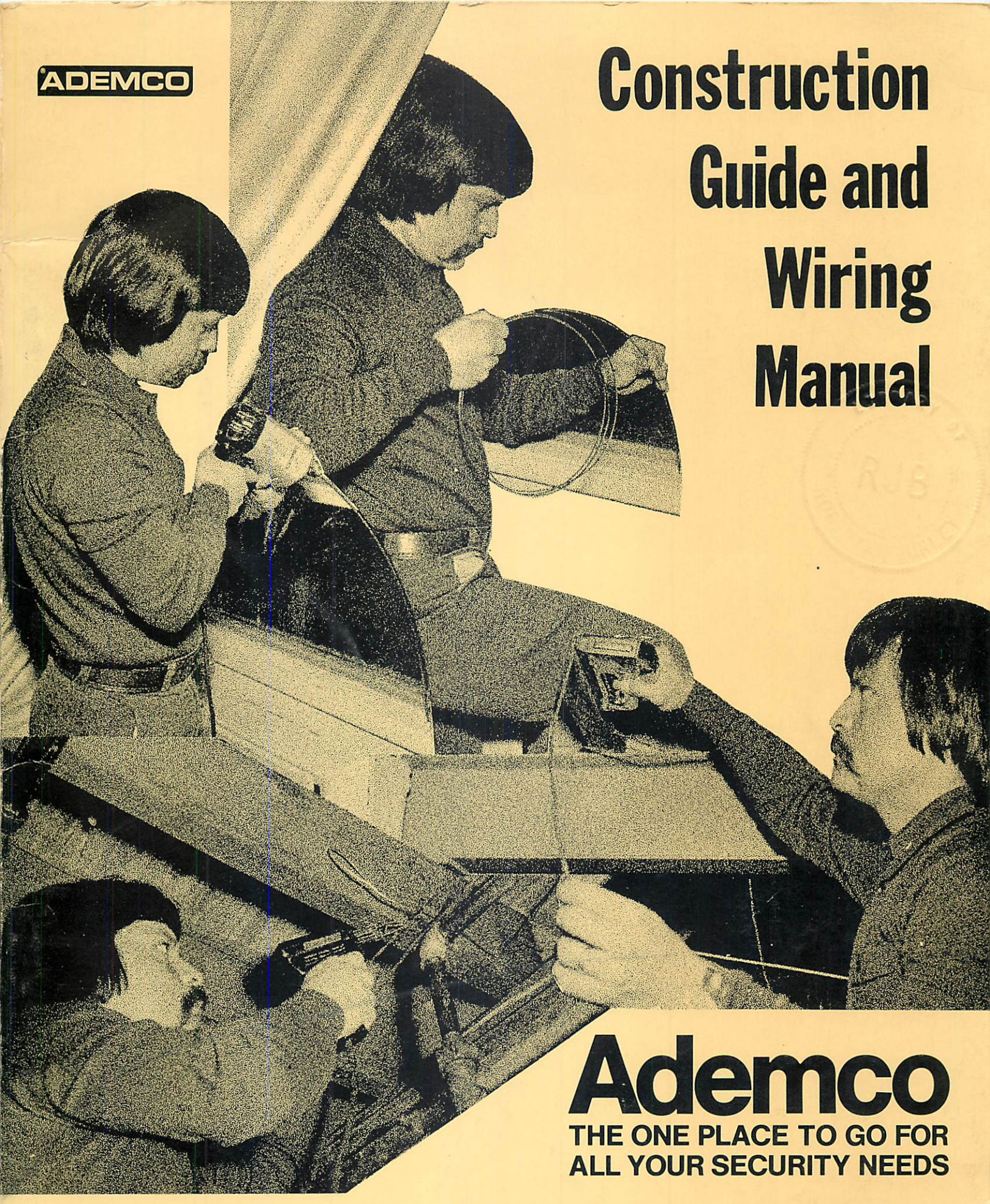
ADEMCO

Construction Guide and Wiring Manual



Ademco

THE ONE PLACE TO GO FOR ALL YOUR SECURITY NEEDS

ALARM DEVICE MANUFACTURING COMPANY

A DIVISION OF PITTWAY CORPORATION

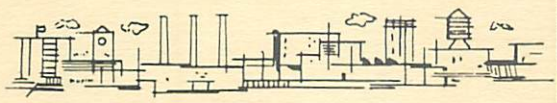
165 Eileen Way, Syosset, L.I., New York, U.S.A. 11791

ACKNOWLEDGEMENT

This manual was published through the cooperation of Honeywell Protection Services and Ademco. Its value is limitless for both the new and experienced installer or salesman.

The basic framework for this manual was established through years of experience and researching the methods used by various companies. We wish to acknowledge and thank the many friends and companies for providing an excellent base from which to start.

The author and publishers disclaim any liability for injury and/or losses due to information given or omitted in this manual. This manual does not replace appropriate local codes and ordinances or U.L., F.M., and NEMA standards.



CONSTRUCTION GUIDE AND WIRING MANUAL

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INTRODUCTION

This booklet contains the basic information required by an installation man to enable him to route wiring throughout a building. It does not include point-to-point wiring information for various fire alarm or security devices.

The instructions given are written for individuals who are not familiar with building construction, wiring techniques, conduit bending, and general installation problems.

The booklet is split into six sections, each of which covers one of the areas of concern listed below.

- Basic Construction Methods
- Wiring Techniques
- How to Bend Conduit
- Soldering and Wire Splicing
- Hardware Items
- Additional Information

BASIC CONSTRUCTION METHODS

The most difficult problem of wiring is the installation of wires inside walls and ceilings in existing buildings. It should be obvious that a building which has not been finished inside (walls and ceilings not completed) can be wired with relative ease. This points out an important fact to keep in mind when involved with new construction. The wire runs and installation should be timed so as to minimize effort and allow easy installation. Normally that time would be before wallboard, paneling, or ceilings are installed. About the time plumbing and electrical rough-in is completed. Wiring in old construction (building is up and occupied), as stated previously, can be extremely difficult for even the experienced installer.

Normally commercial buildings have telephone, plumbing, and electrical chases (open spaces running between floors in which building plumbing and electrical wiring is run) so wiring between floors is not difficult. A commercial building is normally multi-story, constructed of steel girders, reinforced concrete floors, with outside walls of glass or similar solid material.

Wiring in most cases is limited to interior walls of normal construction (studs, paneling, etc.) and above hung ceilings. Note that many hung ceilings will not support a great deal of weight (men, conduit, equipment, etc.). The wiring is then run to the chase area and run from floor to floor. The chase area can usually be located by following the ducts, piping, or electrical wiring. These services normally spread across each level of the building like a spider web, with the chase at the center. If local codes permit, an elevator shaft can be used to run wires from floor to floor.

There are small commercial buildings which are built of concrete block construction. These buildings are normally only one or two stories high. The same wiring procedures are used in large and small commercial buildings.

Small apartment buildings and homes are erected by way of frame construction. Some typical roofs and building styles are shown in Fig. 1 and Fig. 2. The type of roof will limit access to some of the outside walls. If the building has a hip roof, access to all the outside walls from the attic is blocked. With a gable roof the rafters rest directly on the double plate of the wall on two sides of the building, allowing access to two outside walls. In order to fish a wire through the wall from the attic, you must be able to drill a hole in the double plate. Drilling a hole is extremely difficult when the double plate supports the rafters and there isn't enough room to use a drill. It may be possible to drill up from the mounting hole using a flexible bit. The drilling procedures are covered in the Wiring Techniques section of this sheet.

It is important that the individual doing the wiring understands how buildings are put together. This knowledge will help him choose the easiest and most direct way of wiring the building. Frame construction methods both old and new are shown in Fig. 3 and Fig. 4 respectively.

Balloon framing (Fig. 3) can be detected by the fact that the wall studs extend the full height of the building. This type of construction was most generally used prior to 1935.

Platform framing (Fig. 4) has each level framed separately. The first floor is built on top of the foundation to provide a platform for the walls. The wall studs are one story high and when erected, provide support for the second floor joists. The second story walls are constructed in a similar manner. This is the most frequently used method of construction at this time.

Commercial type construction is illustrated in Fig. 5. It should be noted that many of the commercial construction methods for partitions and interior walls are similar to those used for frame type (residential) construction.

Basement and first floor joists are shown in Fig. 6. Most wiring being run from one area of the building to another will be routed through the basement. Several different types of wall construction, foundations, and slabs are shown in Fig. 7.

Detail drawings of construction techniques are shown in Fig. 8 through Fig. 12. These drawings provide a closeup look at possible trouble areas.

Wall framing and construction are shown in Fig. 13 through Fig. 16. Fig. 17 through Fig. 20 show roof construction details. These twenty illustrations show how the skeleton (framework) of a frame building is constructed.

To the frame of the building are added various types of wall coverings, doors, and windows. The types and styles of wall coverings are not discussed here but the different types of doors and windows are shown. Fig. 21 through Fig. 27 cover most commonly encountered door styles and types. Fig. 28 through Fig. 33 show the window designs and construction used for homes and small commercial buildings.

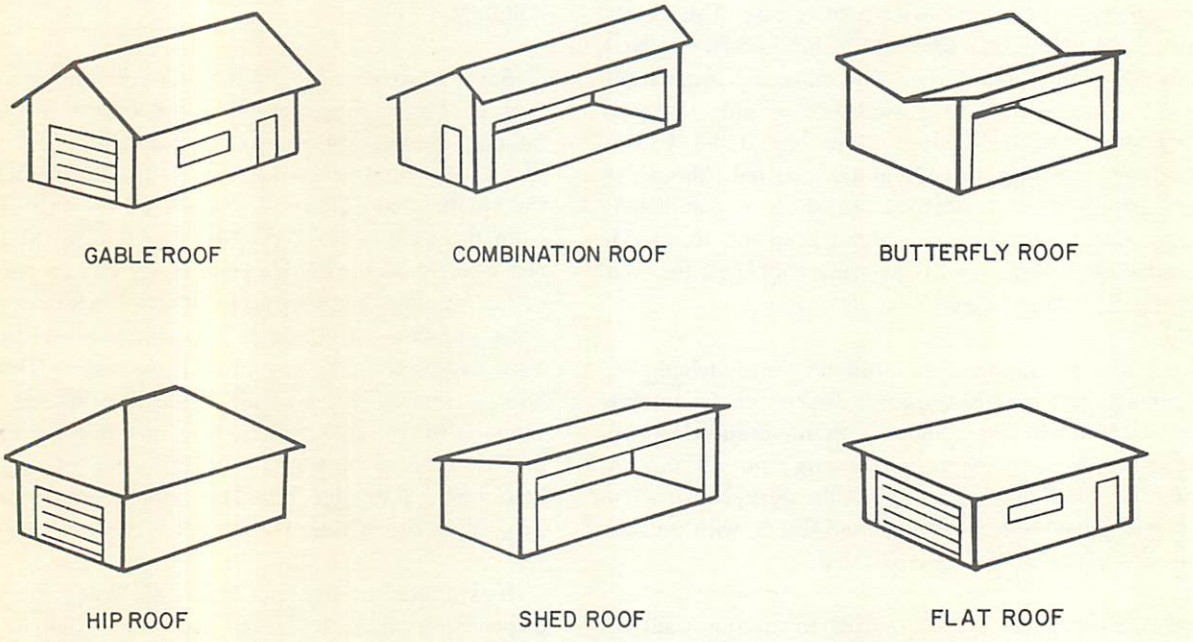


Fig. 1—Types of Roofs.

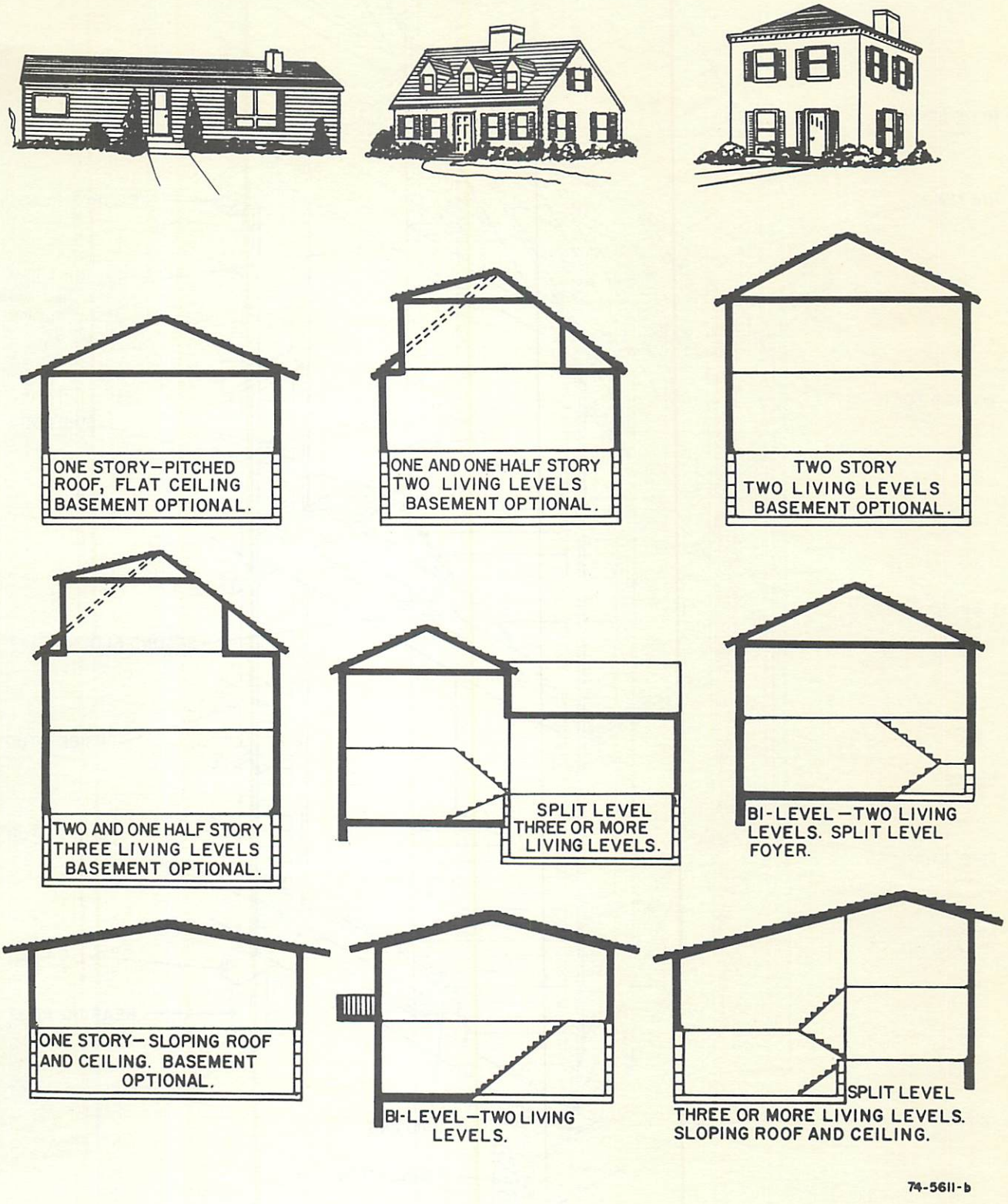


Fig. 2—Architectural Designs and Styles.

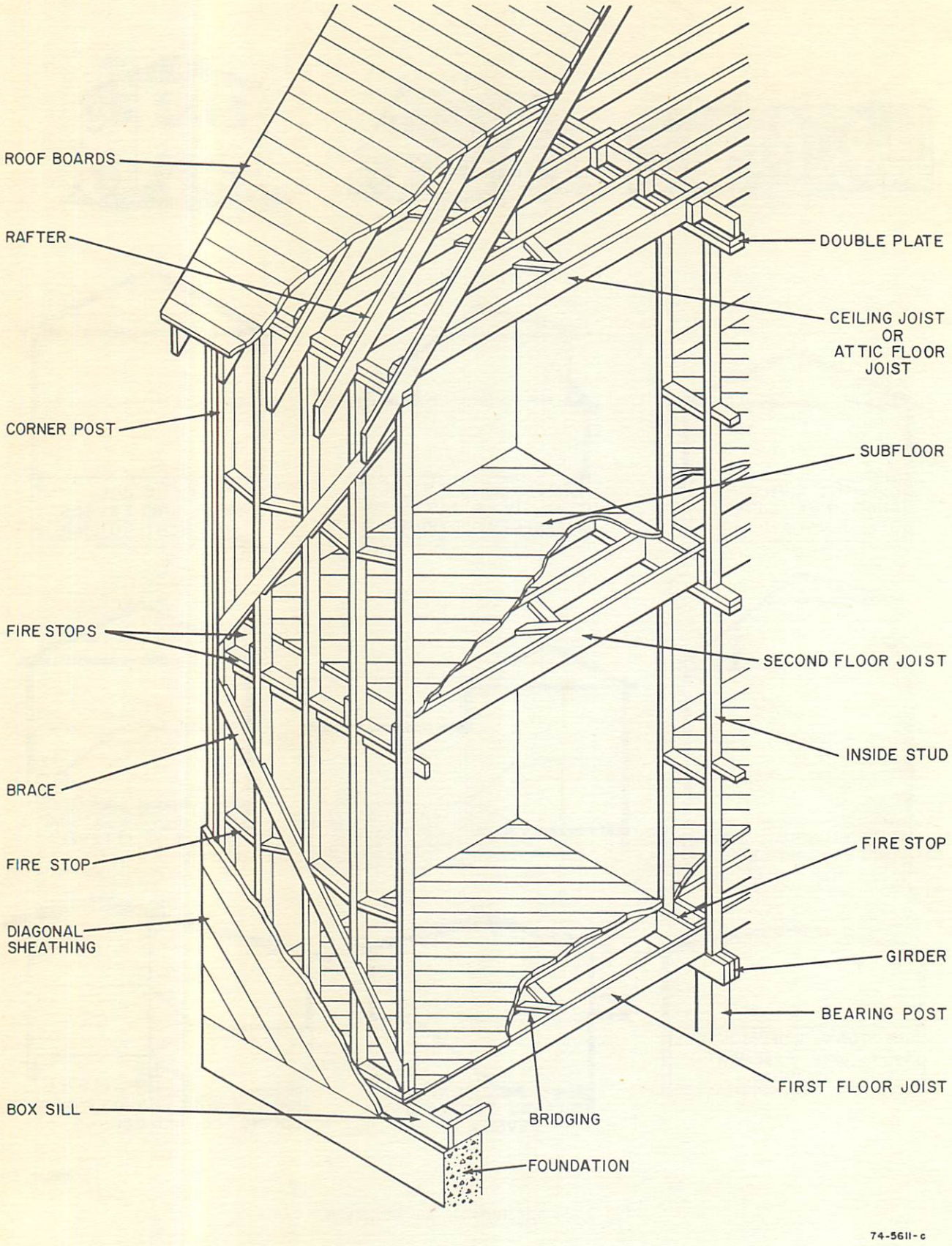


Fig. 3–Example of Balloon Type Framing – Old Construction.

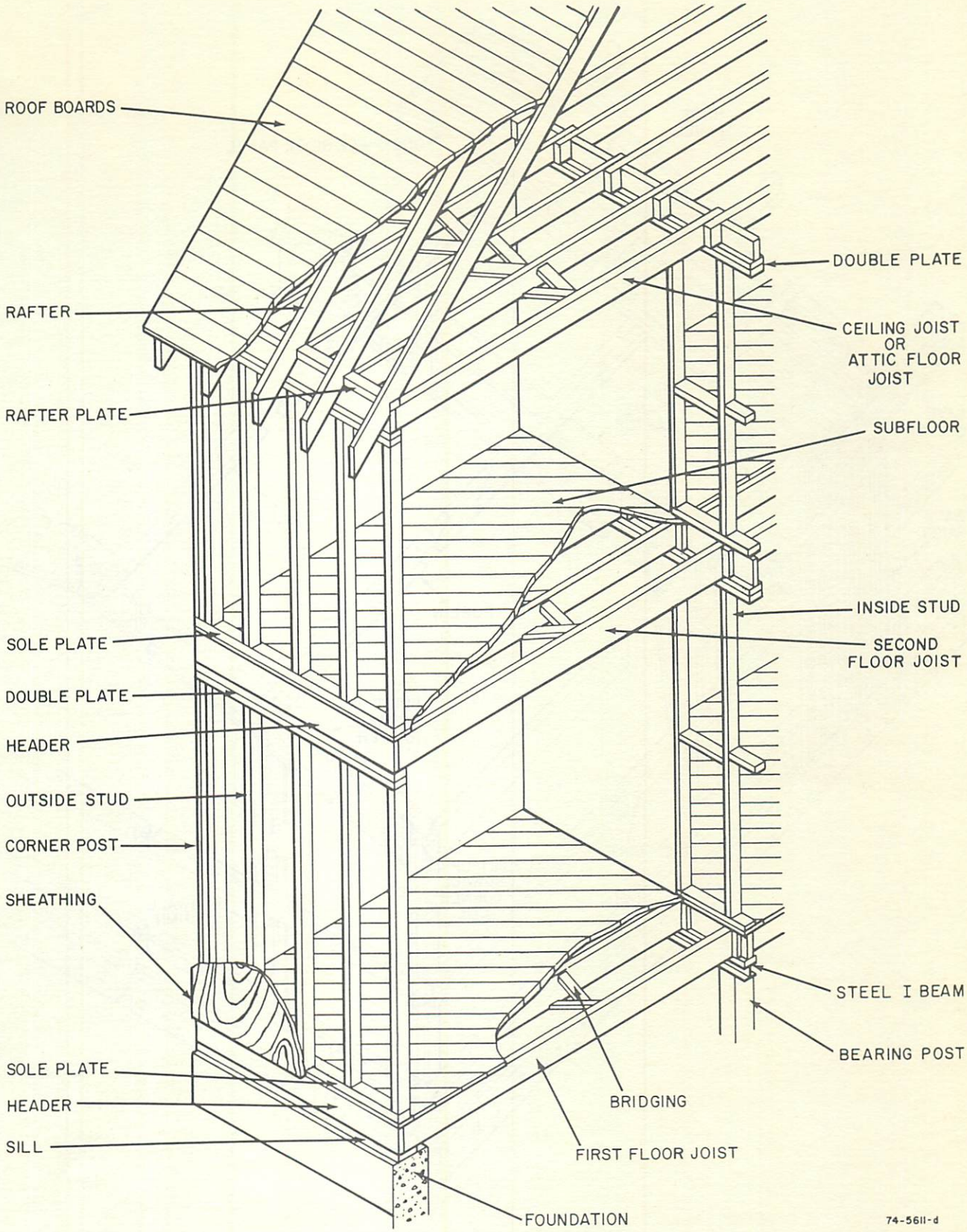


Fig. 4–Example of Platform Type Framing – Modern Construction.

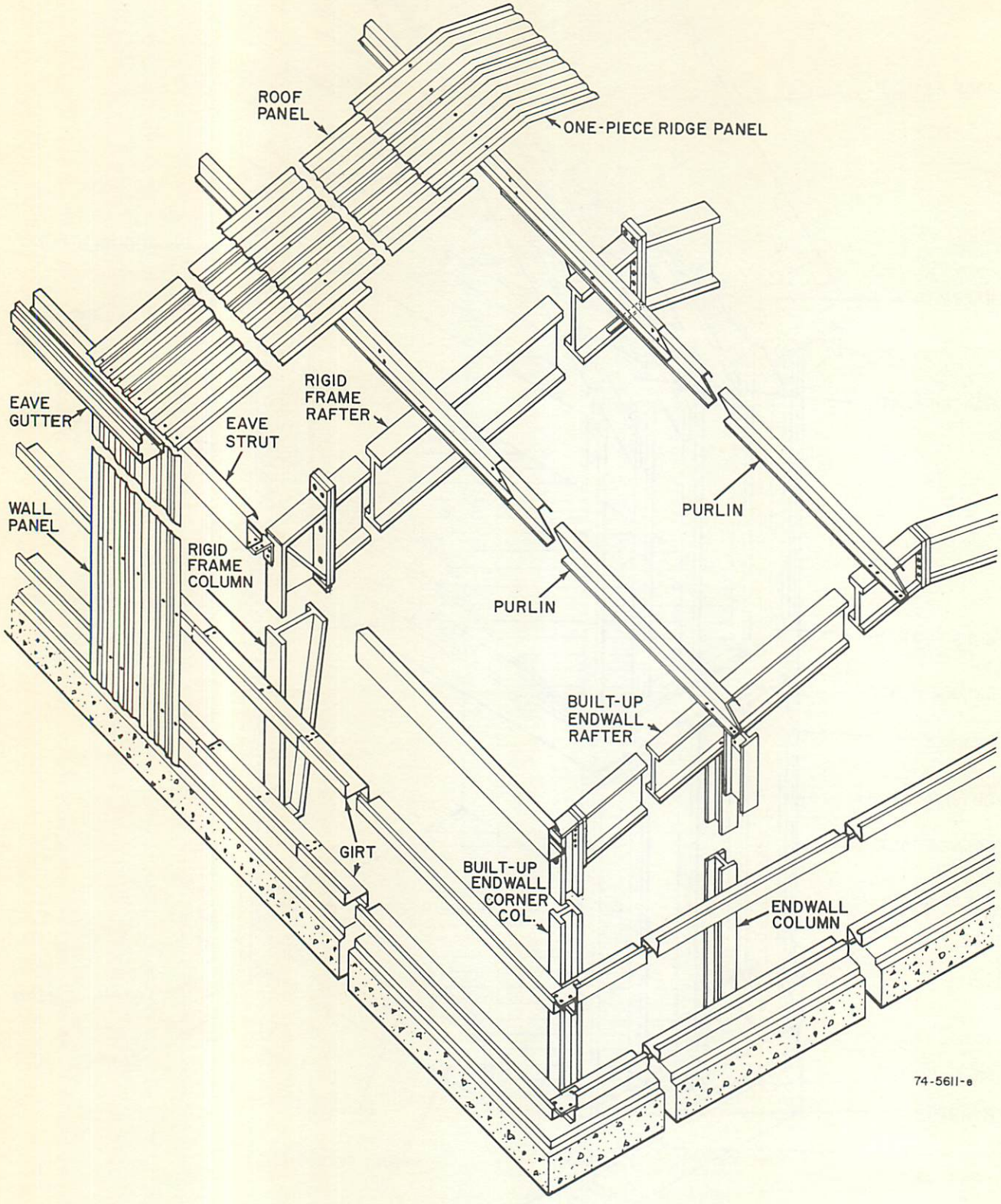


Fig. 5–Typical Prefab Type Commercial Building.

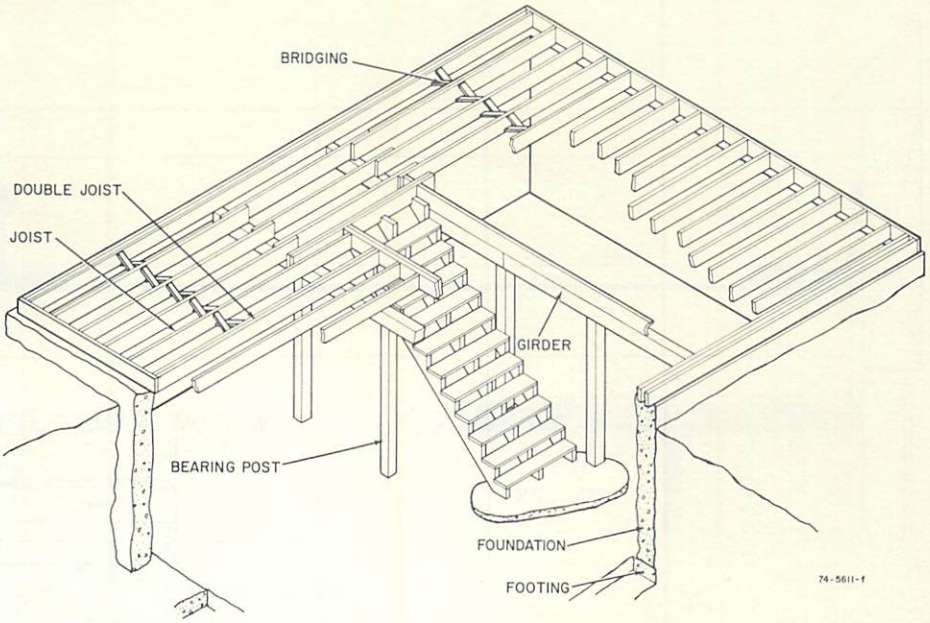


Fig. 6–Example of Foundation and Basement Supports.

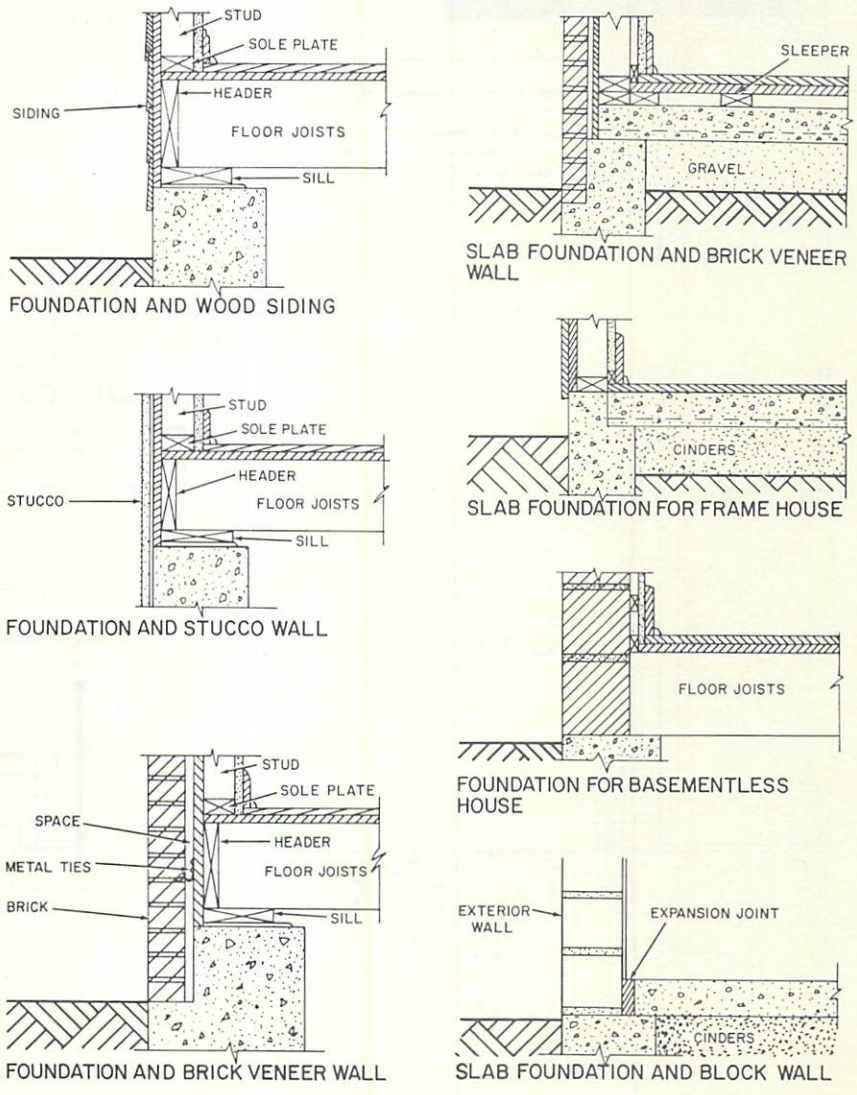


Fig. 7–Typical Foundation and Wall Construction.

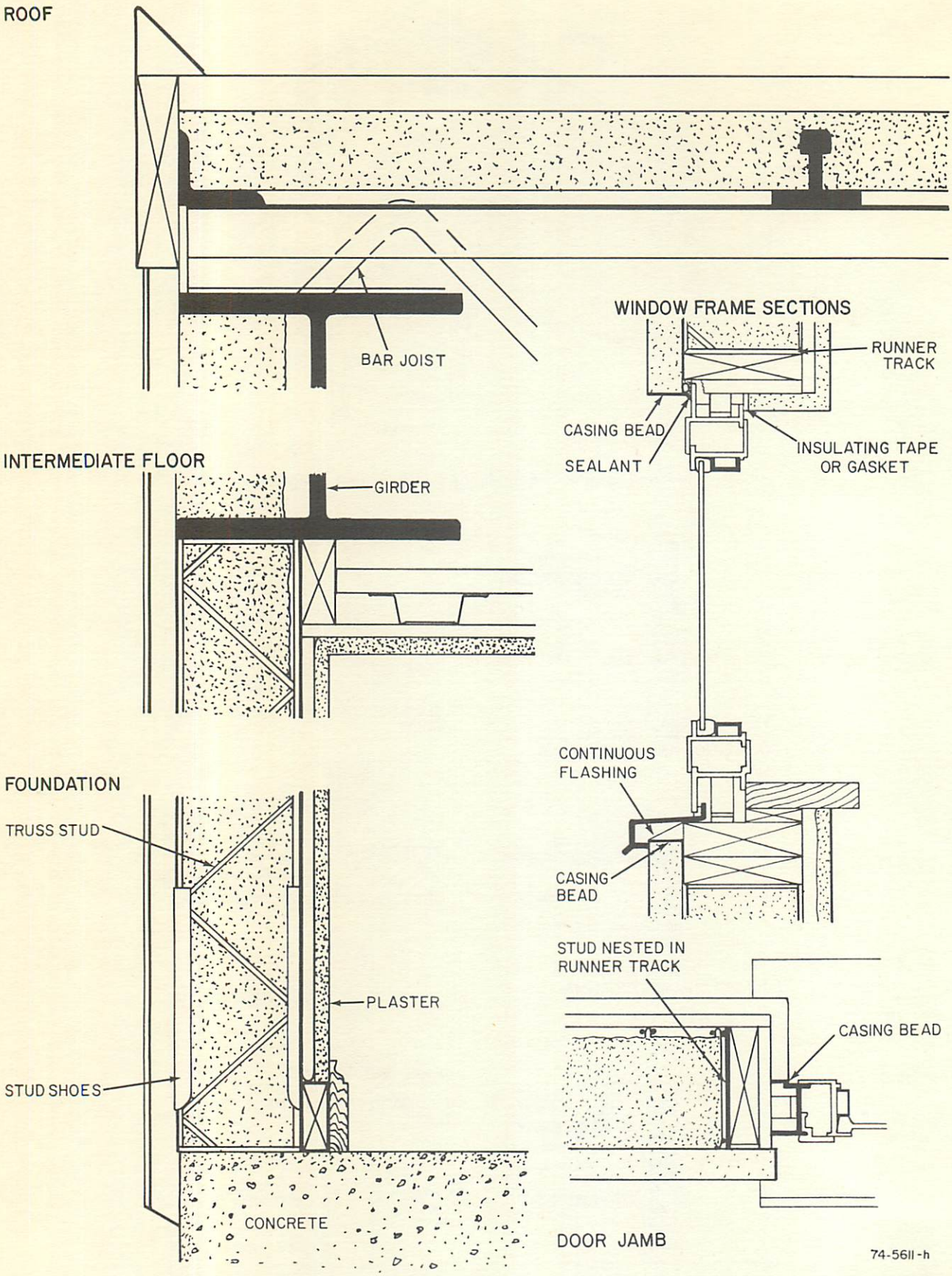


Fig. 8—Cross Section View of Commercial Type Construction.

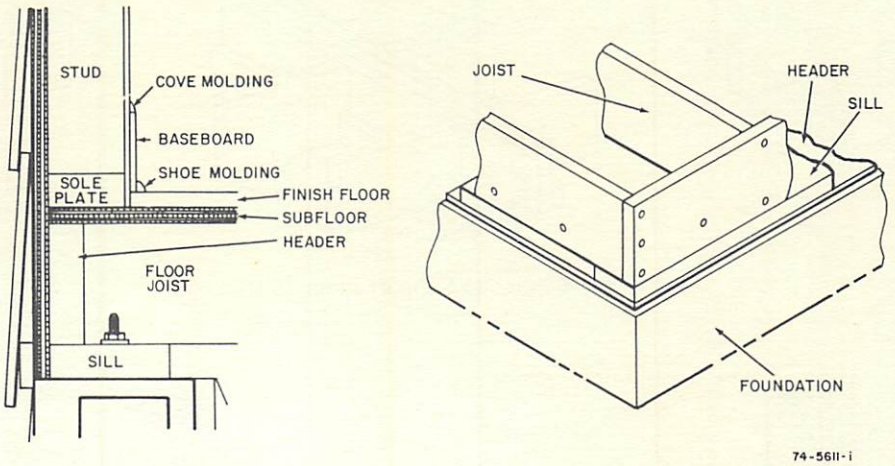


Fig. 9–Typical Frame Construction Foundation and Sill.

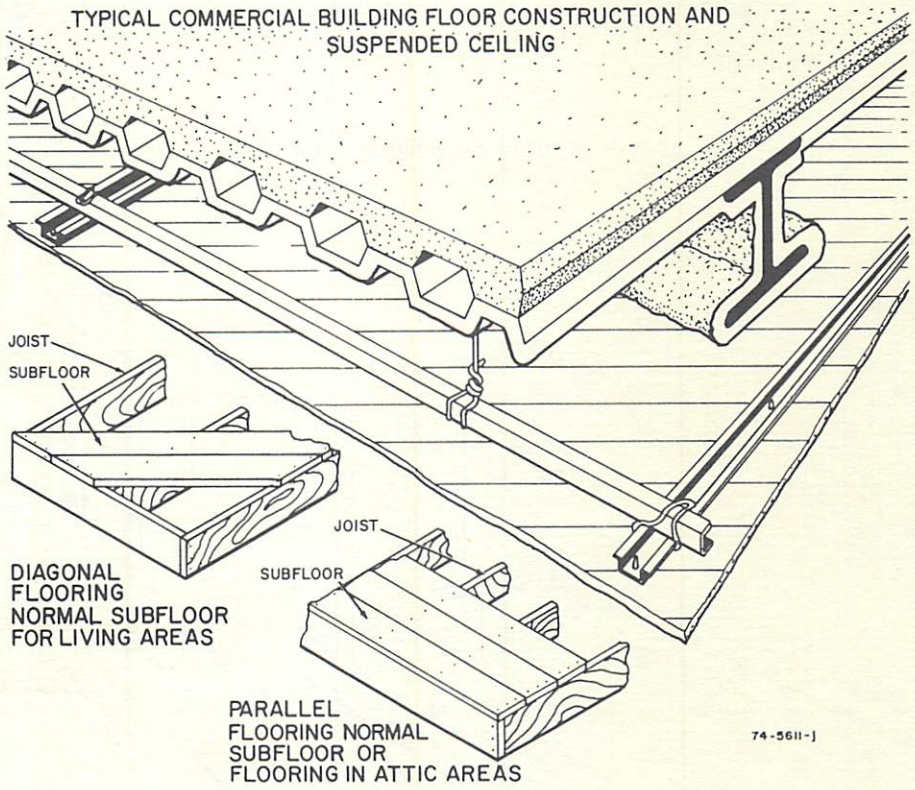


Fig. 10–Basic Floor and Ceiling Construction.

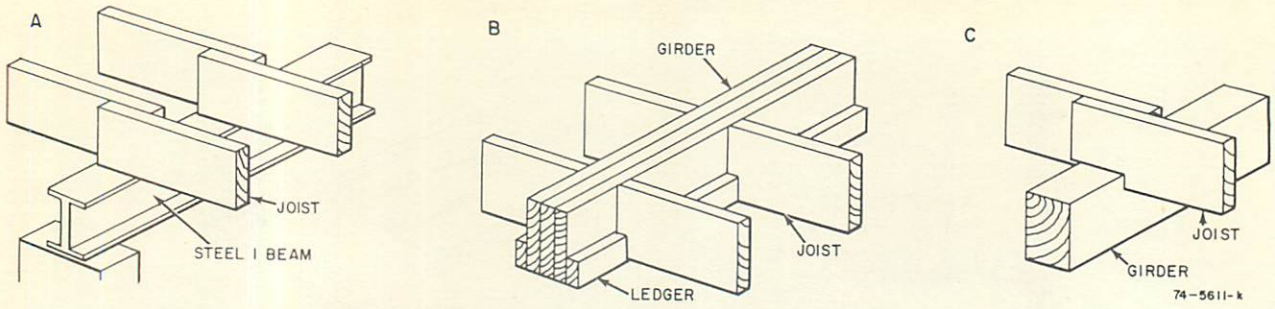


Fig. 11–Girders to Support Floor Joists.

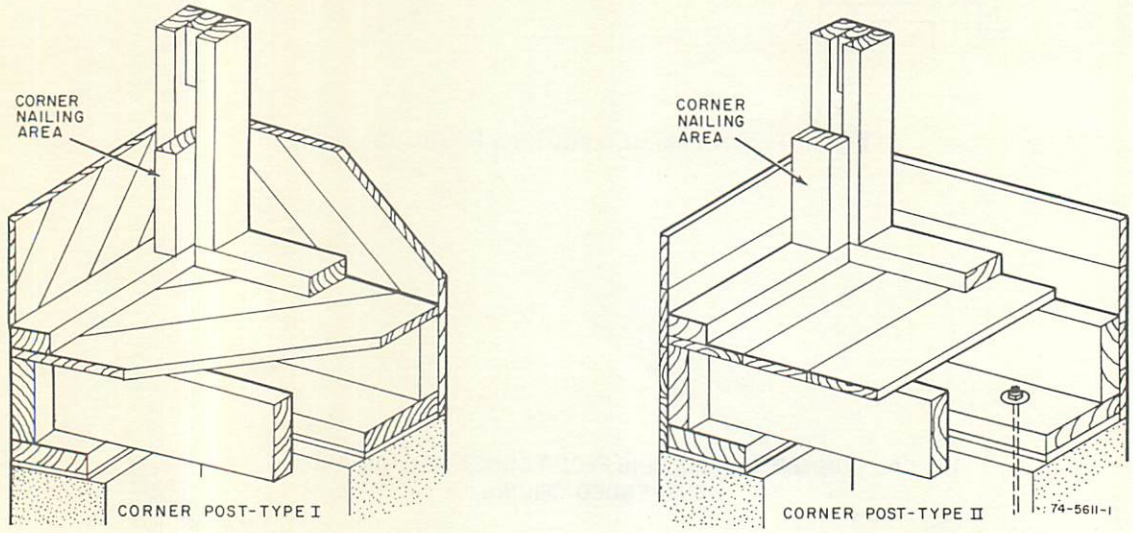


Fig. 12–Corners of Frame Building – Two Types.

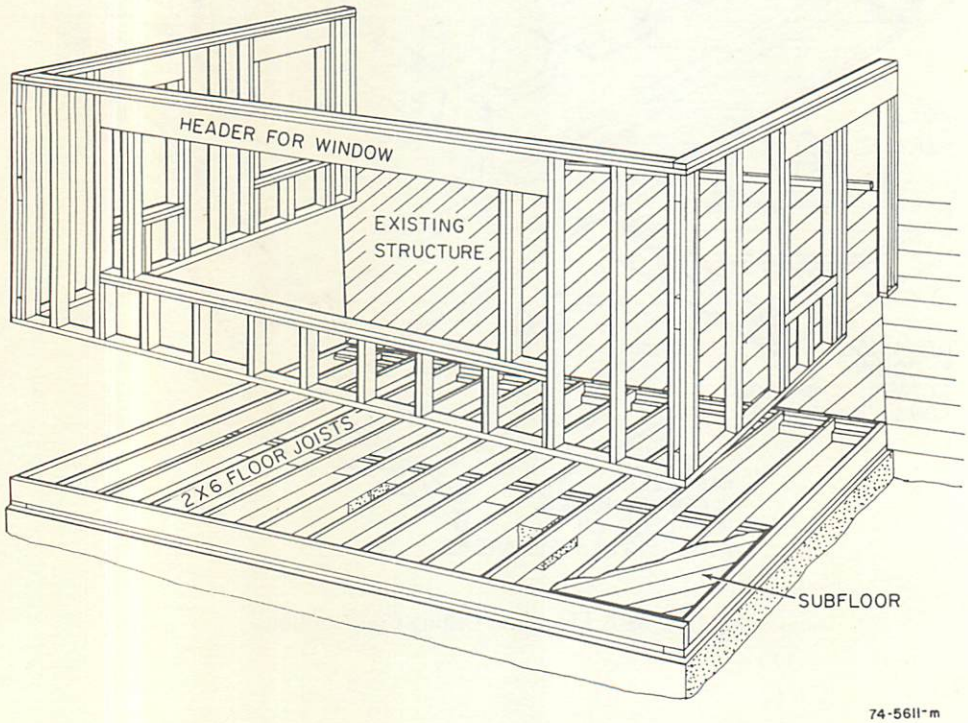


Fig. 13–Sample Frame Construction.

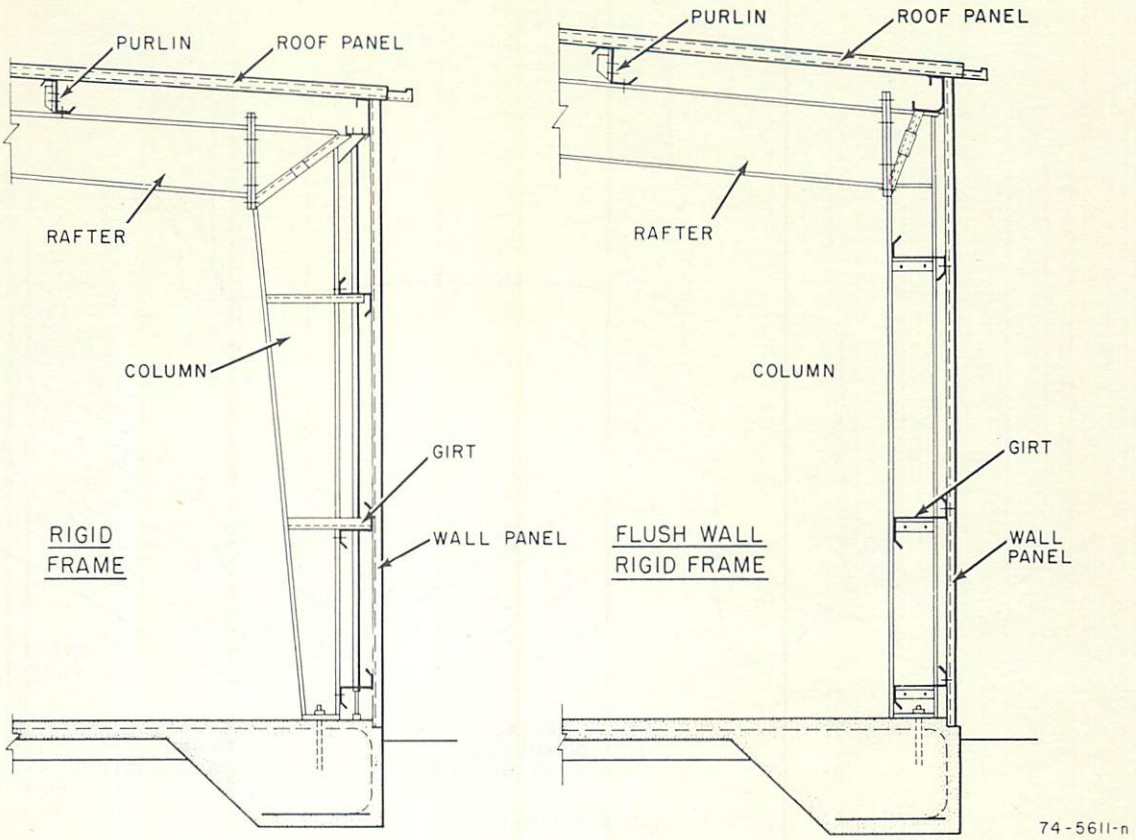


Fig. 14–Sample Commercial Building Construction.

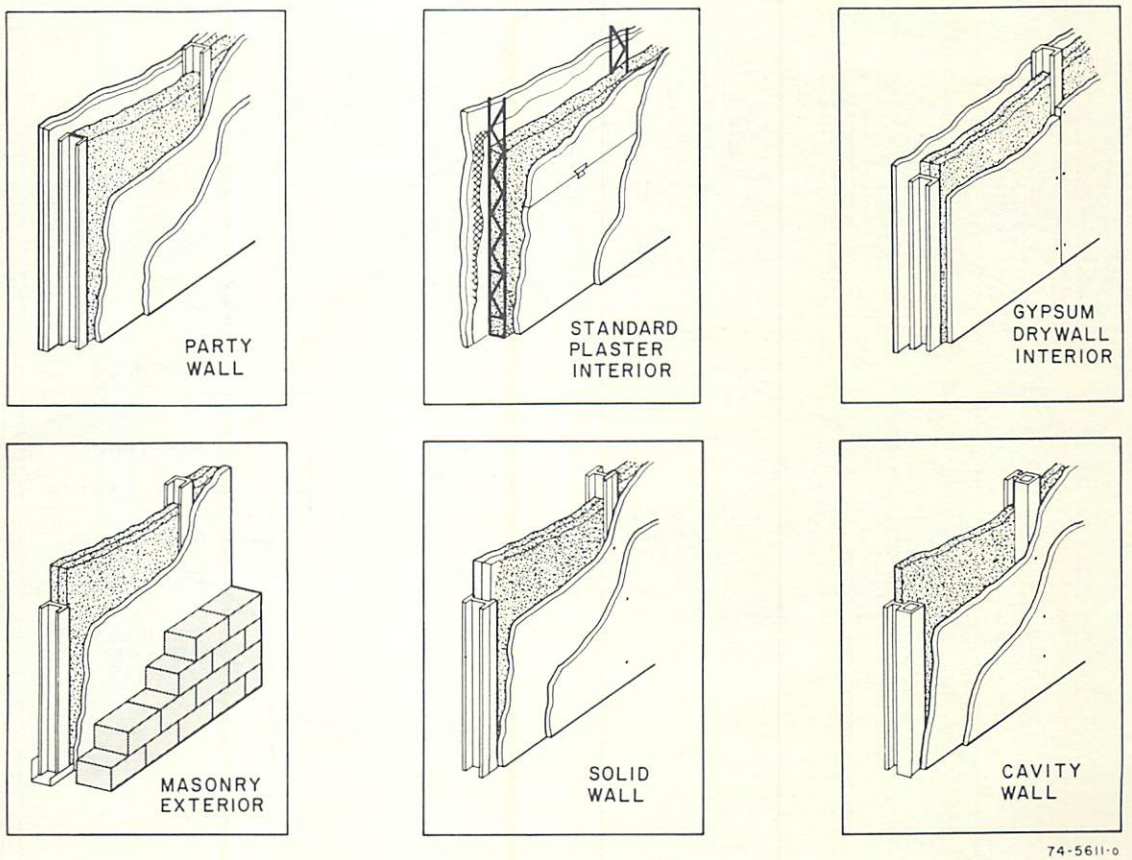


Fig. 15–Typical Commercial Type Wall Construction.

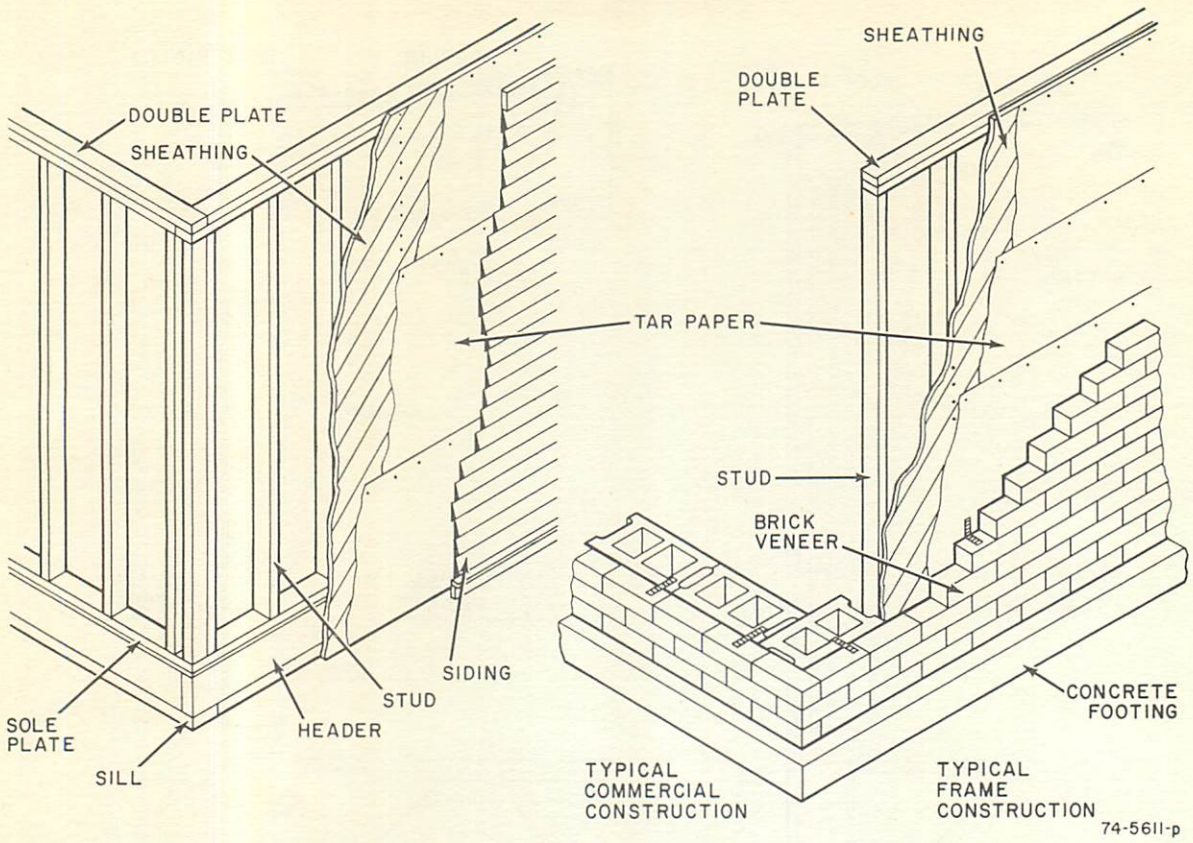


Fig. 16–Sample Exterior Wall Construction and Finishing.

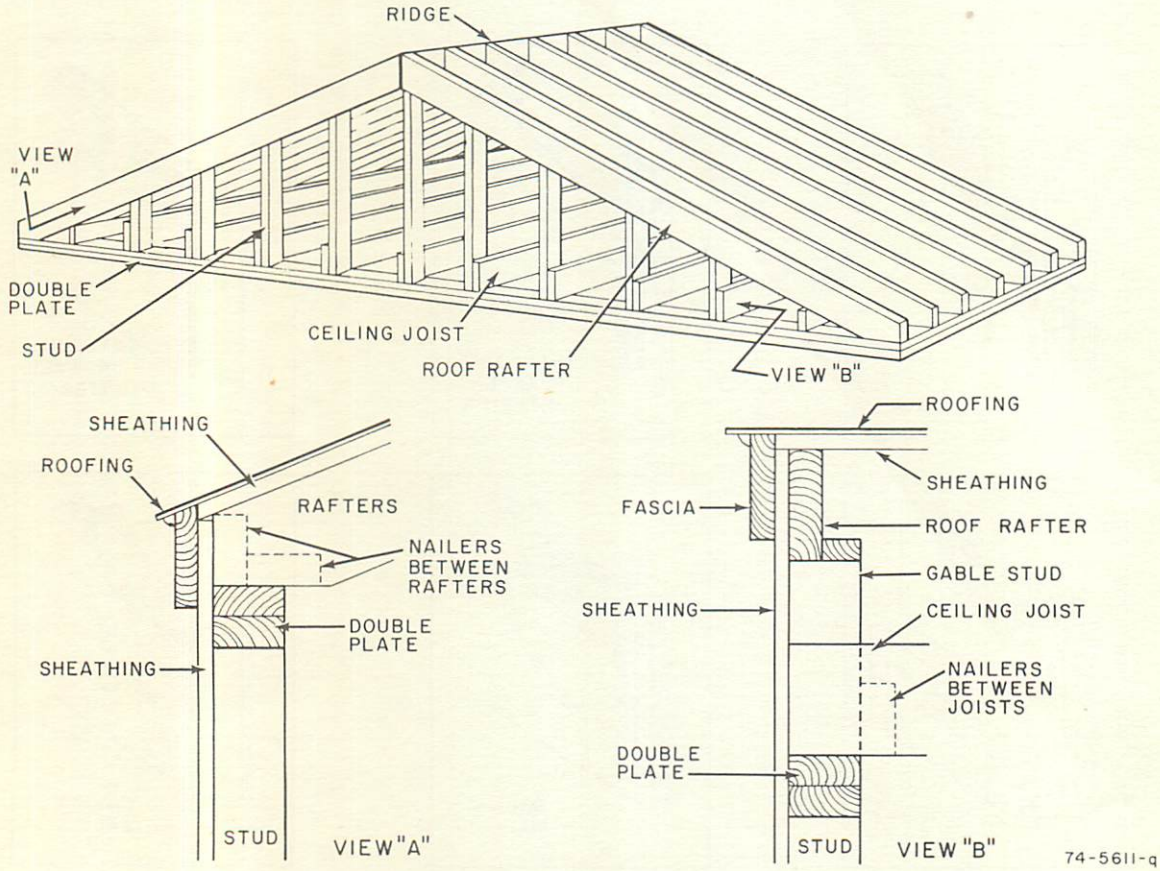


Fig. 17–Frame Type Roof Construction – Gable.

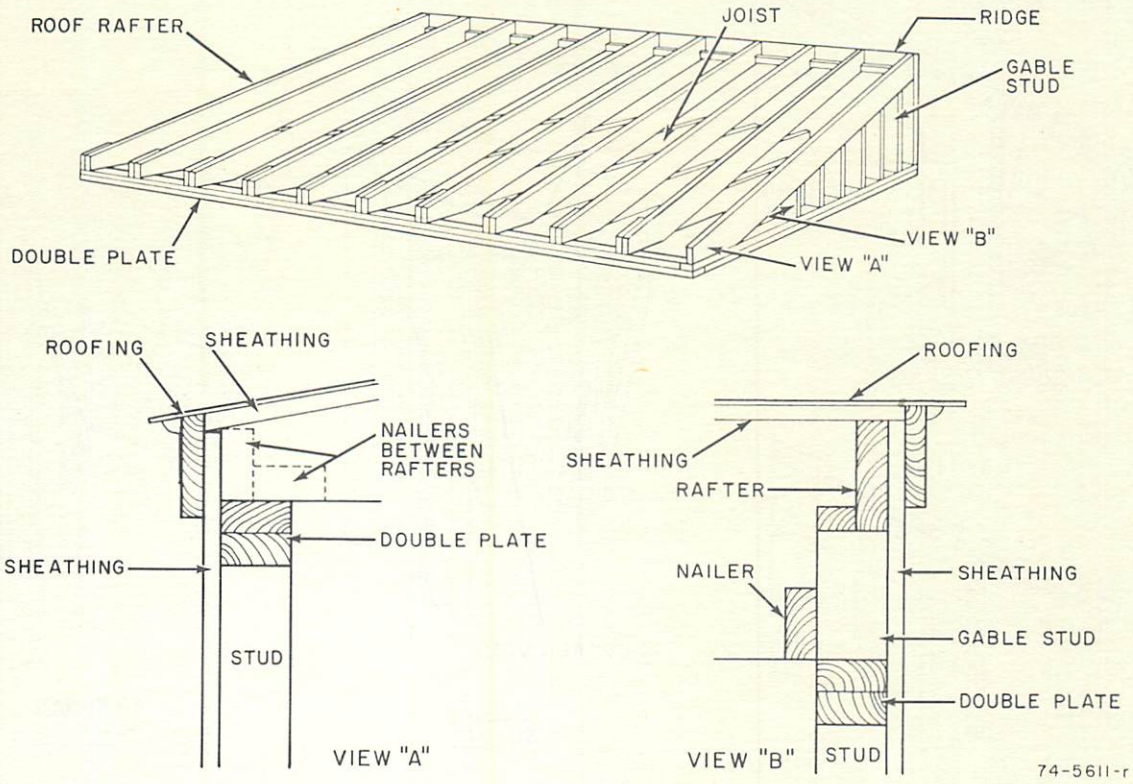


Fig. 18–Frame Type Roof Construction – Shed.

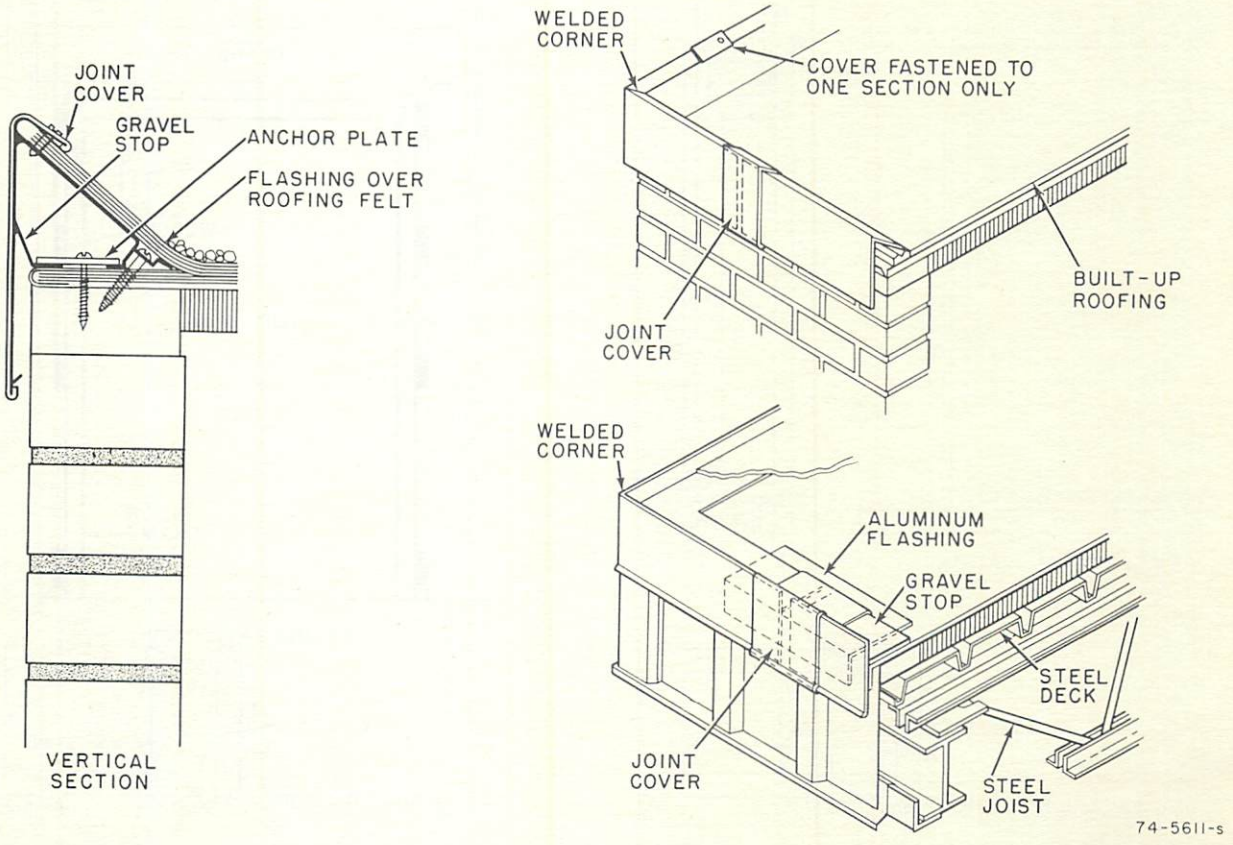


Fig. 19–Commercial Type Roof Construction.

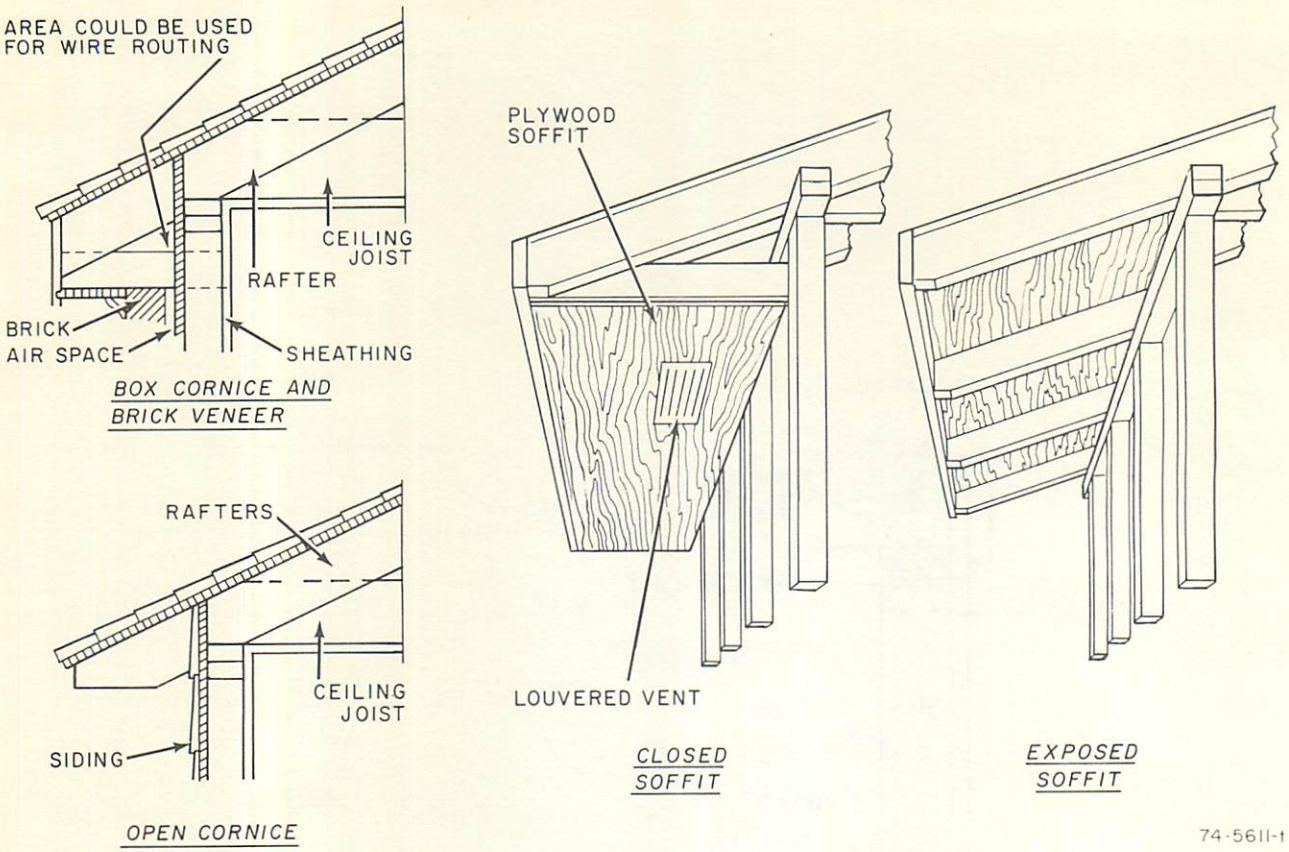


Fig. 20–Sample Soffit and Cornice Construction.

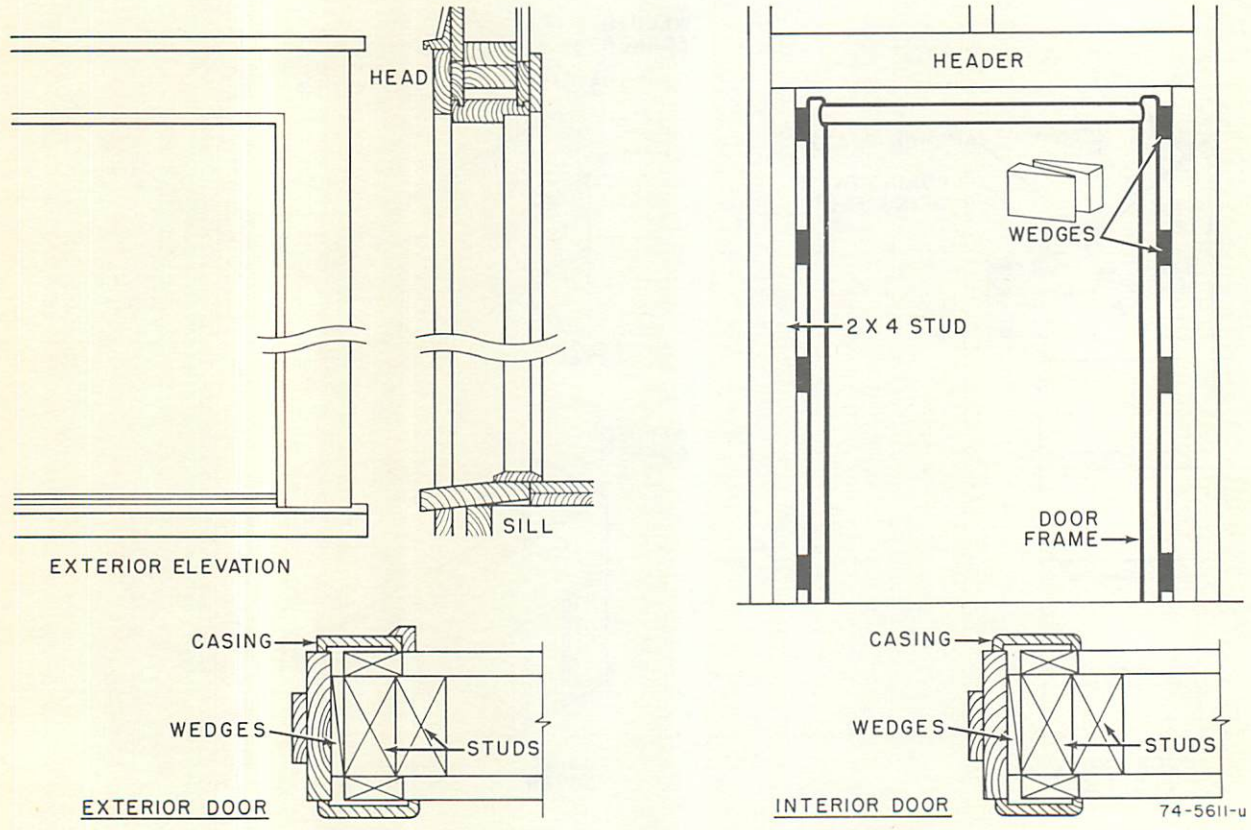


Fig. 21–Door Framing Techniques – Exterior and Interior.

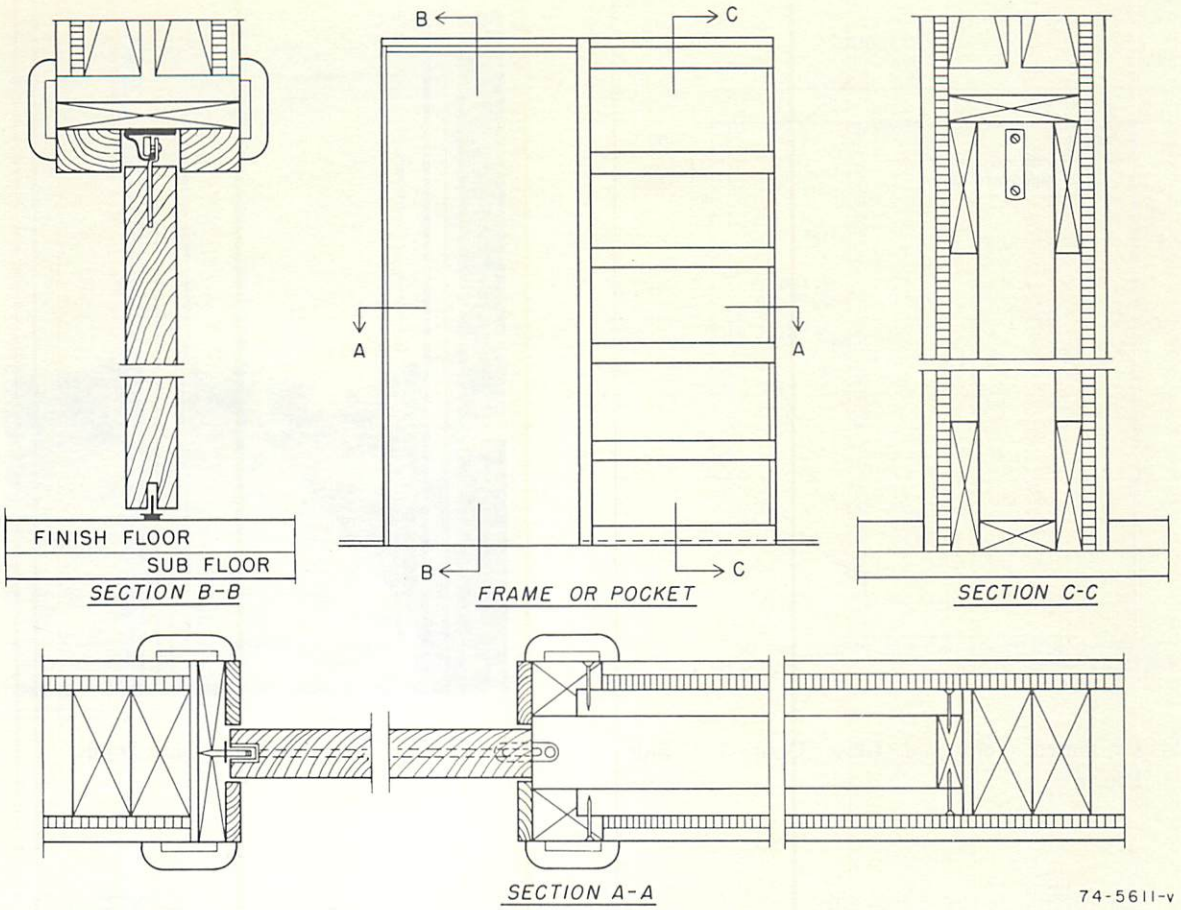


Fig. 22–Framing For Sliding Door.

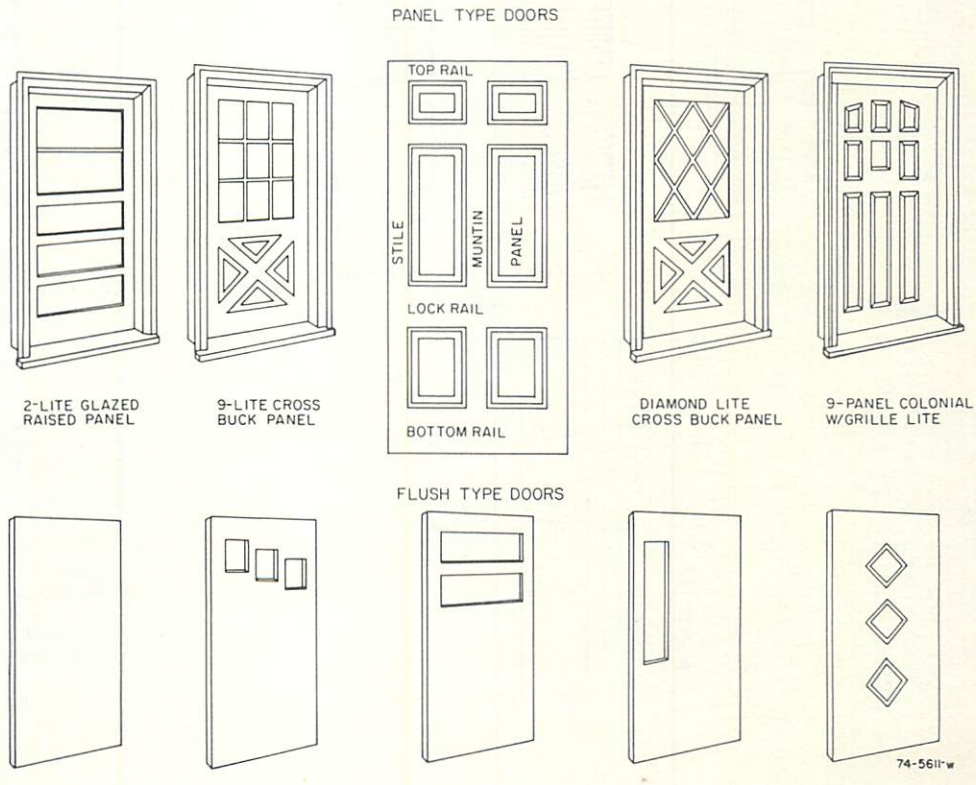


Fig. 23–Examples of Exterior Doors.

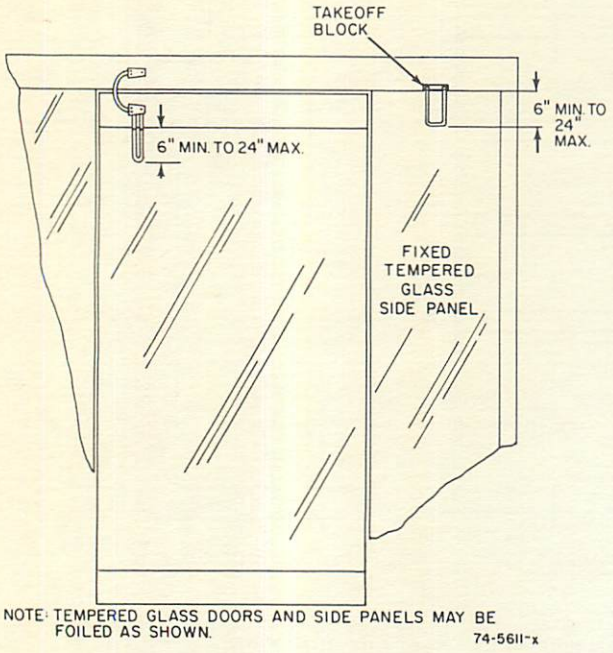


Fig. 24–Unframed Tempered Glass Door and Side Panels.

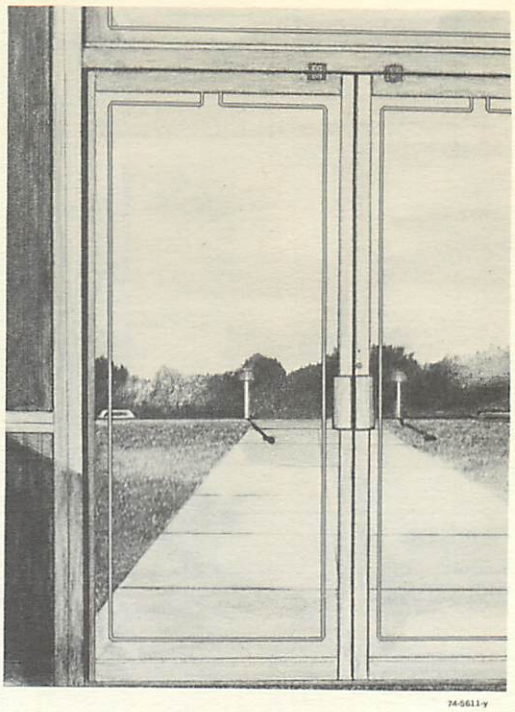


Fig. 25–Metal Frame Glass Door.

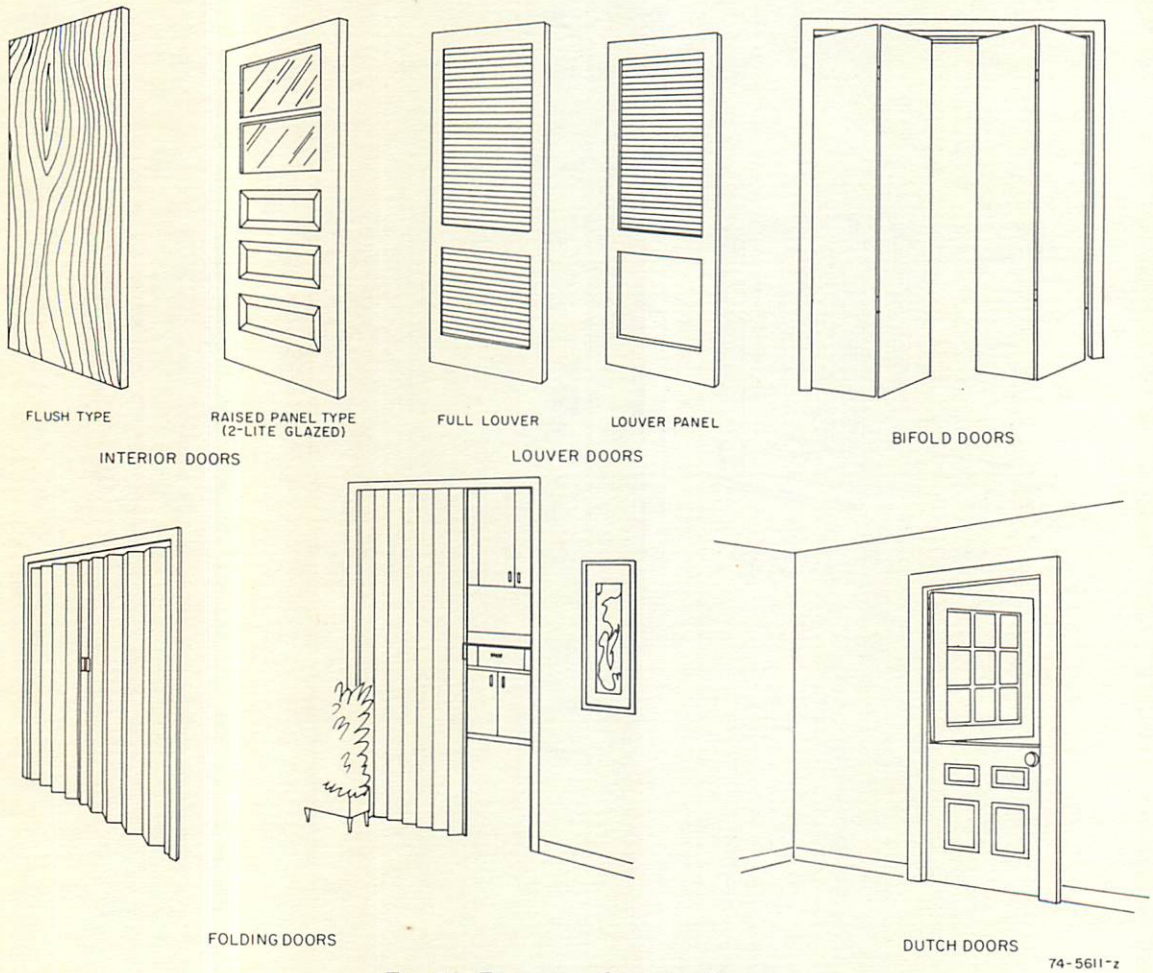
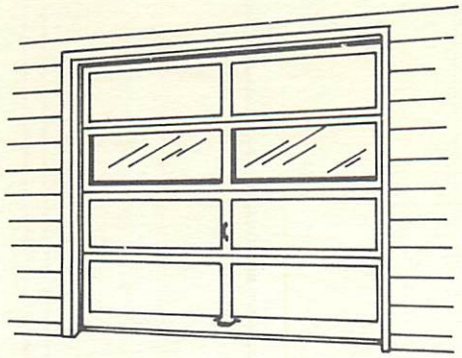


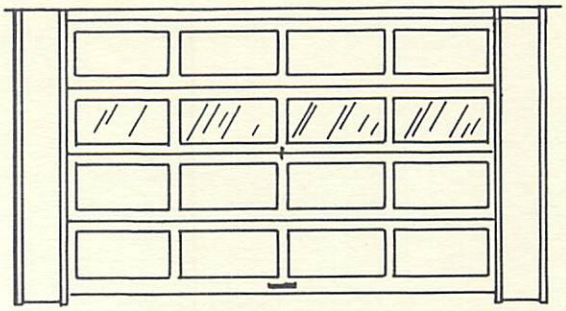
Fig. 26–Examples of Interior Doors.

OVERHEAD DOORS

4-SECTION DOORS

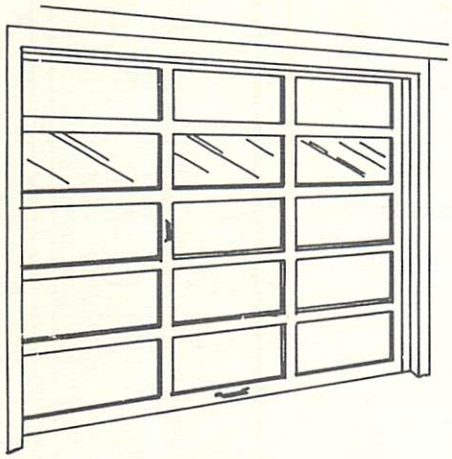


4-SECTION; 2-PANEL

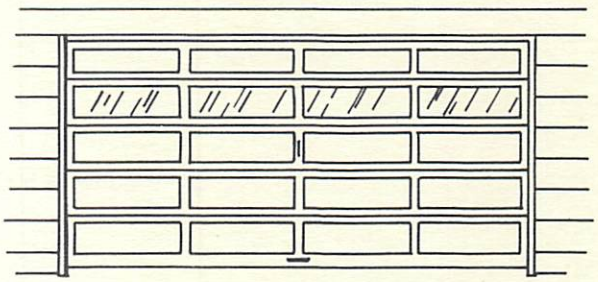


4-SECTION; 4-PANEL

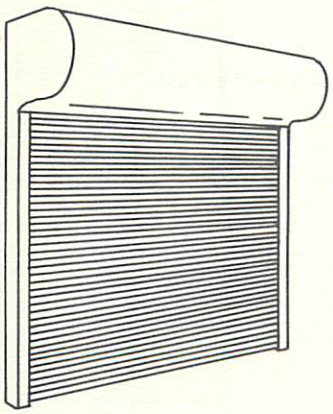
5-SECTION DOORS



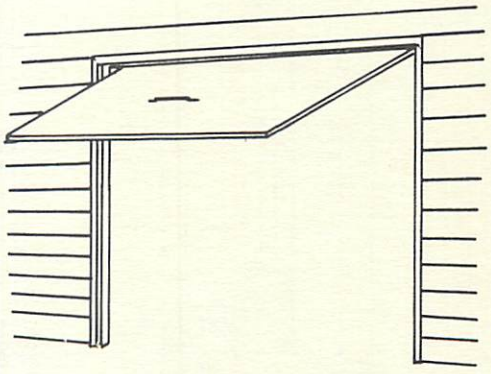
5-SECTION; 3-PANEL



5-SECTION; 4-PANEL



ROLLUP TYPE DOOR
(STEEL, ALUMINUM, ETC.)



TILT-UP TYPE DOOR

74-5611-00

Fig. 27—Examples of Overhead Doors.

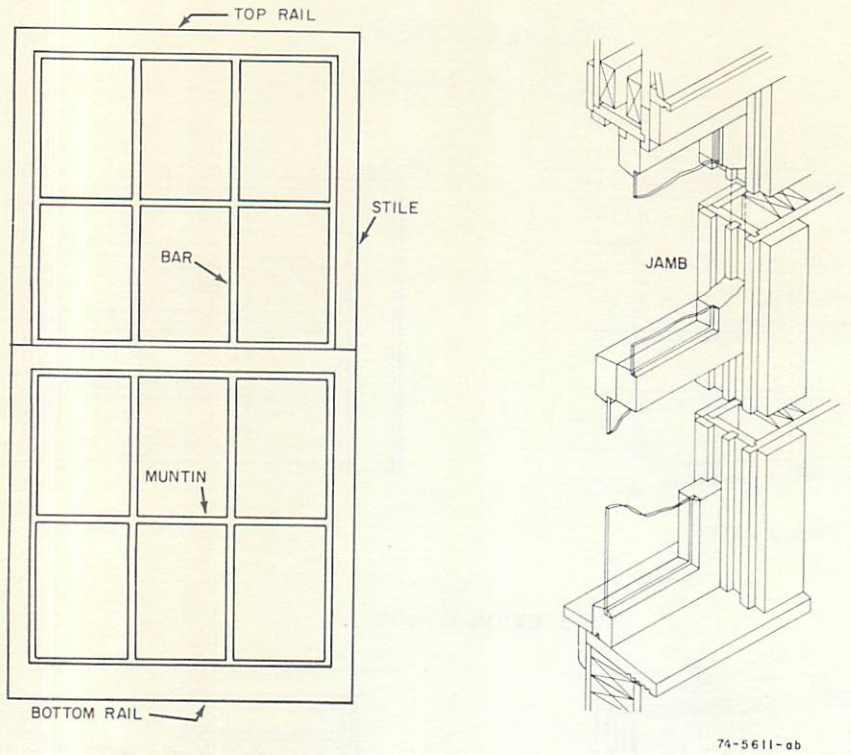


Fig. 28–Window Sash and Cross Section of Frame.

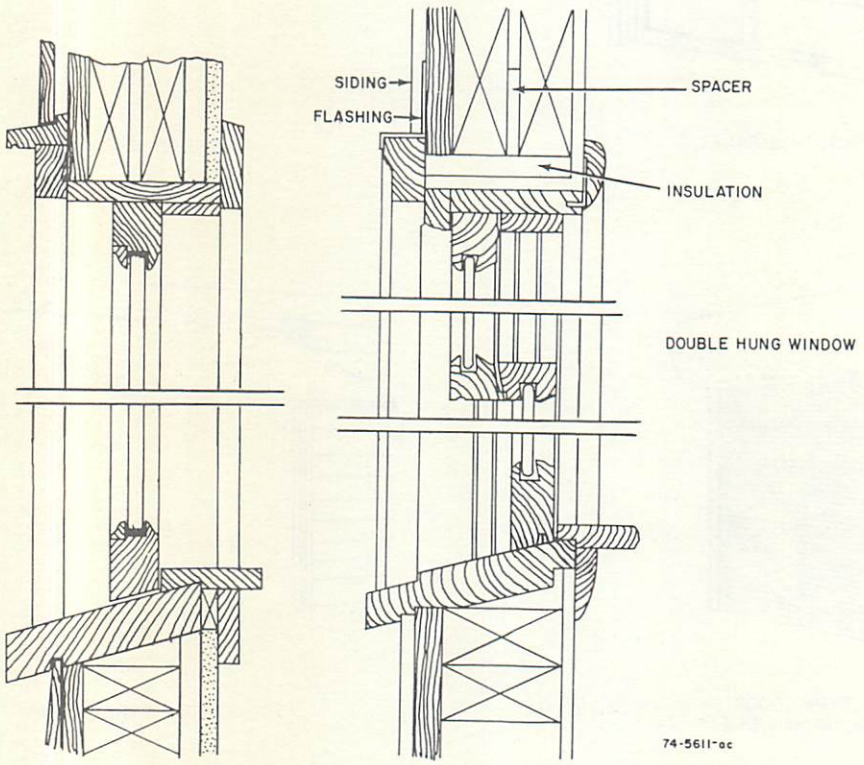


Fig. 29–Typical Construction Methods – Windows.

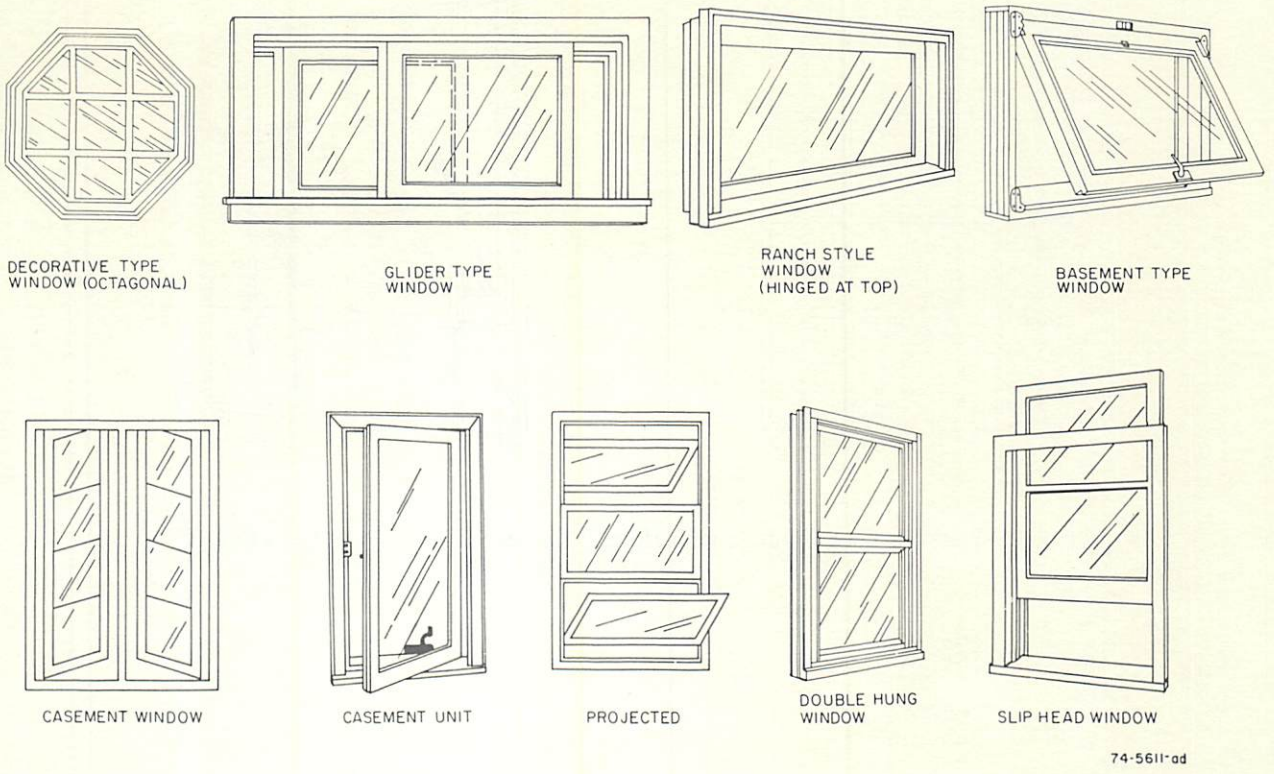


Fig. 30–Examples of Window Types.

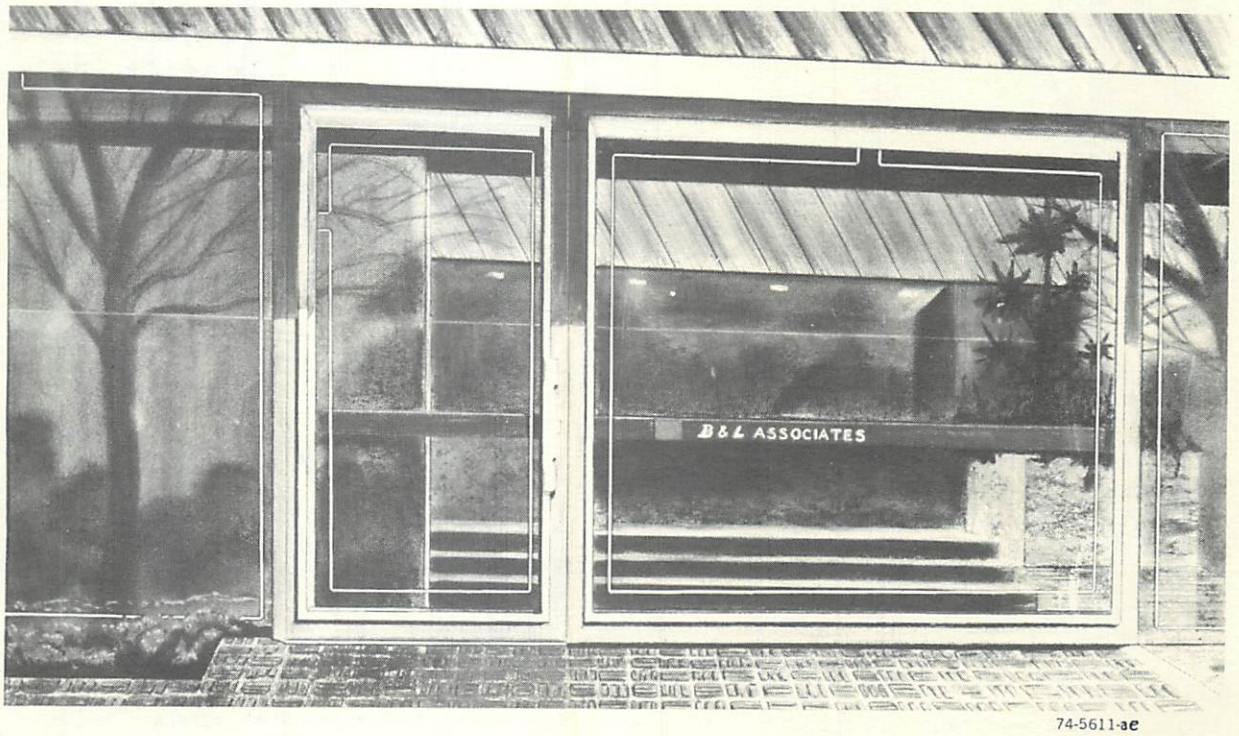


Fig. 31–Framed Plate Glass Show Window – Foiled.

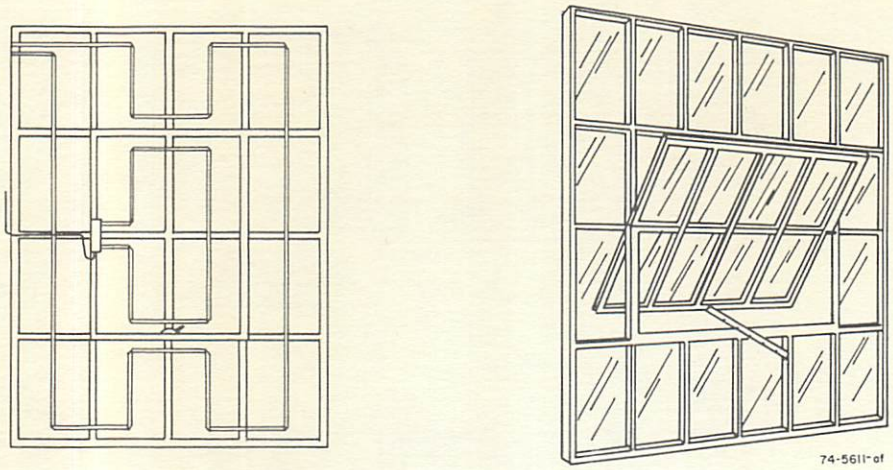


Fig. 32–Fenestra Type Windows with Movable Center Section – Plain Glass Foiled.

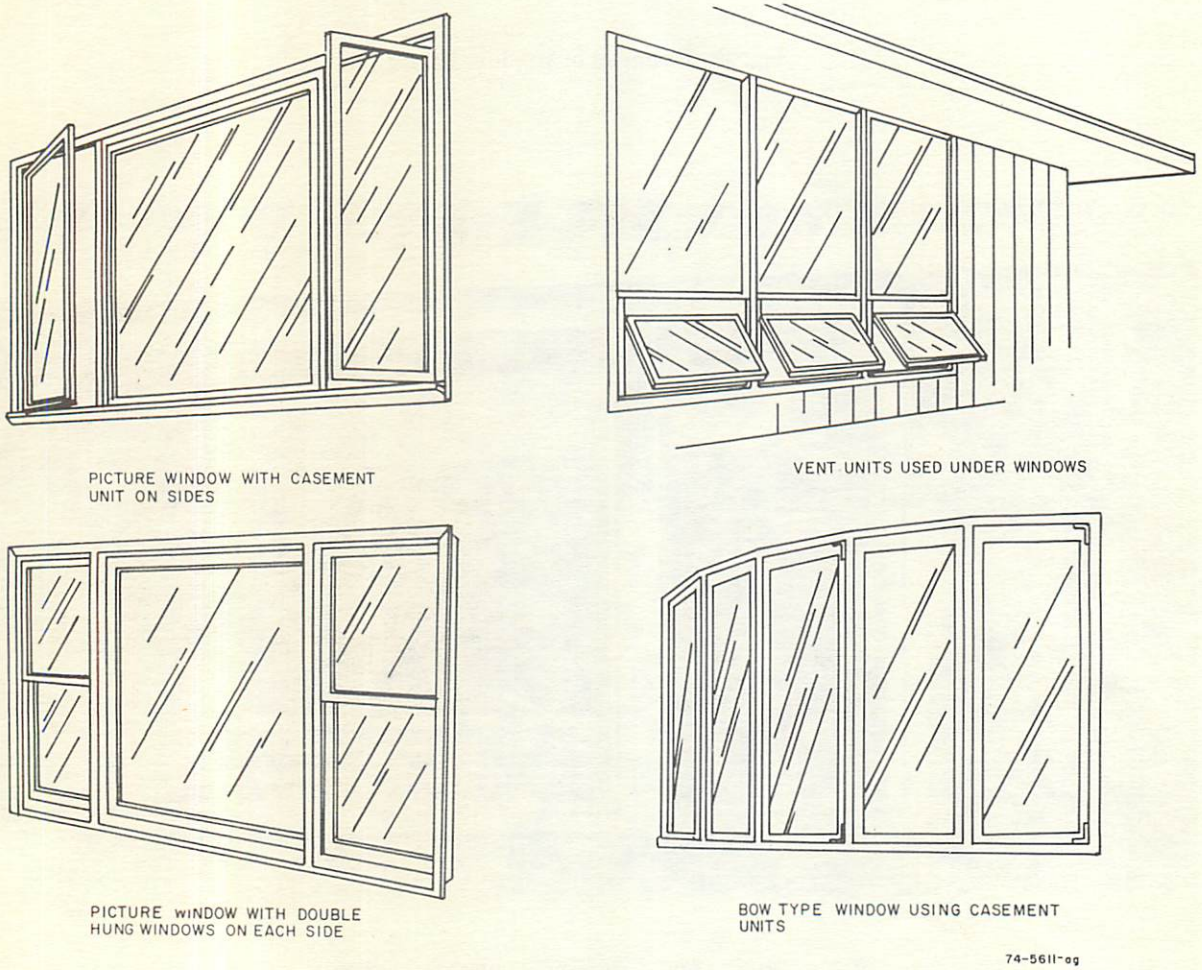


Fig. 33–Examples of Large Picture Windows.

WIRING TECHNIQUES

GENERAL INFORMATION

NOTE: All wiring must be in accordance with local codes, ordinances, and regulations.

Because of the partitioning effect of the studs in a frame wall, wire runs are usually limited to vertical routes, up or down, inside the wall (Fig. 34). Using a flexible bit, it is possible to cross a maximum of three wooden studs if necessary. Normally the wire will have to be run through either the attic or the basement to get from one part of the building to another.

NOTE: Many commercial type buildings use metal studs and plates for partitions and party walls.

Unfinished attics may have no floor boards. The installer will have to use planks to walk on if he intends to run wire through the attic. Four to six 1 x 10 boards, six or eight feet long, should do the job.

Generally, the basement provides the best possibility for running wires from one part of the house to another. Access to the outside walls of a building can usually be gained from the basement.

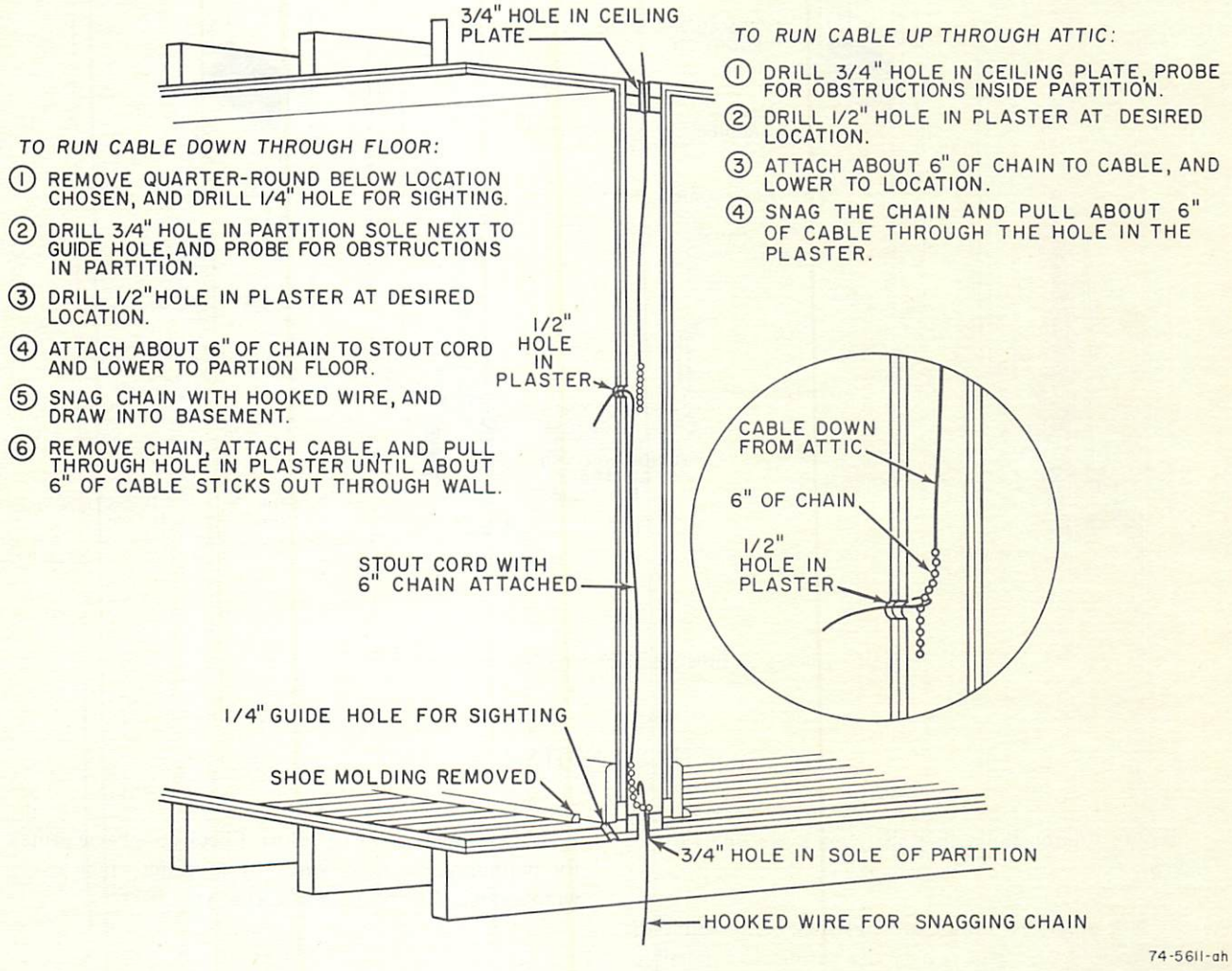


Fig. 34—Example of Wire Pulling Techniques.

The same general procedure used on interior walls usually will work on outside walls.

Two major problems (Figs. 35 and 36) encountered with outside walls are: 1. Difficulty in gaining access to the wall space from the basement or attic. 2. Difficulty in fishing wires because of insulation in the wall.

Normally wire can be fished into an outside wall by drilling a hole, from the basement, at the desired location. With the hole in the right place, use the flexible bit or a fish wire to pull the signal wires into the wall.

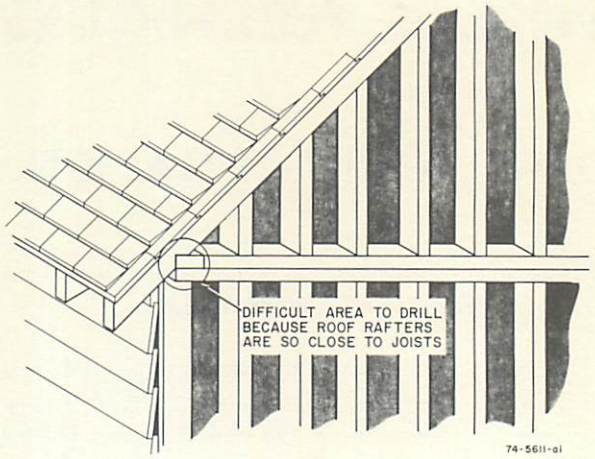


Fig. 35–Access to Top of Outside Walls–Frame Buildings.

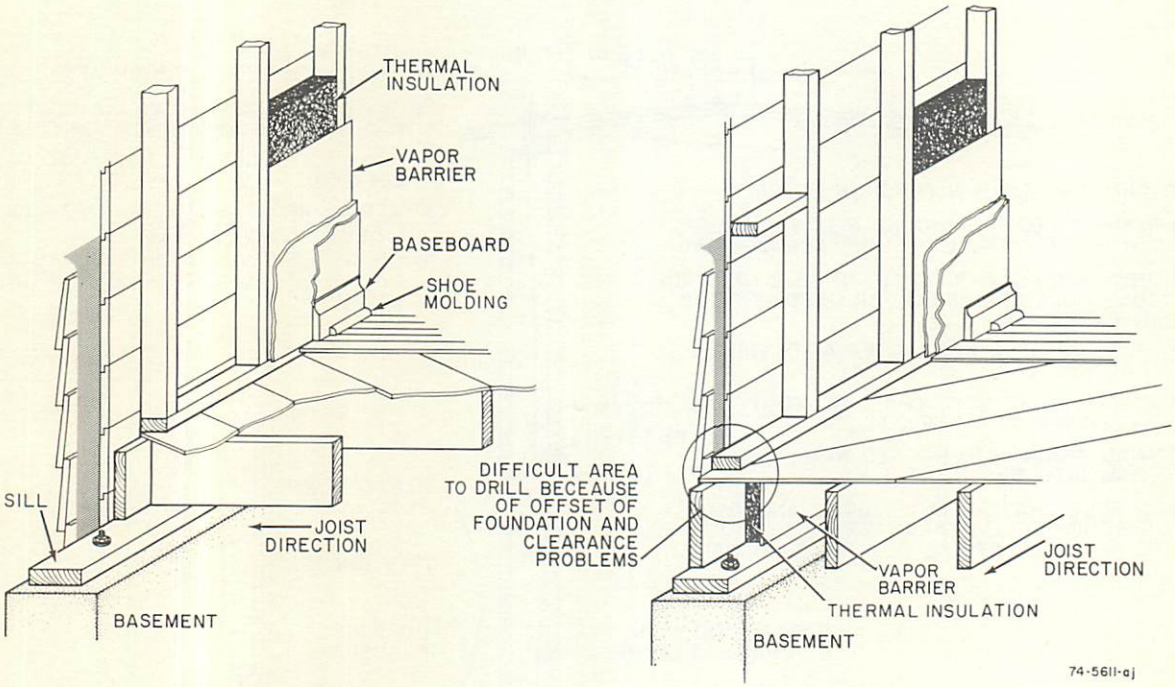


Fig. 36–Access to Bottom of Outside Walls – Frame Buildings.

SPECIAL NOTES:

Before drilling holes in walls, check the items listed below.

1. Is it possible to run exposed wires. Is it possible to use Wiremold type covers over the wiring. Is it possible to run wires through a closet (basement to attic) or other such area.

2. Drill holes as a last resort. Check area to be drilled for plumbing, electrical wires, or anything which might wrap around the drill such as carpet yarn.

3. After holes have been drilled, check with a tape measure for proper clearance and depth.

RUNNING WIRES TO BASEMENT

METHOD 1

If it *is* possible to drill up into an outside wall from below, use the following procedure and Fig. 37.

1. Locate the hole in one of the following ways:

   a. Measure from some object such as conduit, pipe, heating duct or electrical wires that go into the same wall.

   b. Remove the shoe molding from the baseboard. Drill a small guide hole (1/4-inch or less) through the floor at the selected location or drive a finishing nail through the floor as a guide. Use this hole as a guide to determine the proper location at which to drill the hole from below.

   c. Replace the shoe molding when finished.

2. Drill up through the floor boards and sole plate into the wall.

3. Run fish wire through hole into wall and pull signal wires.

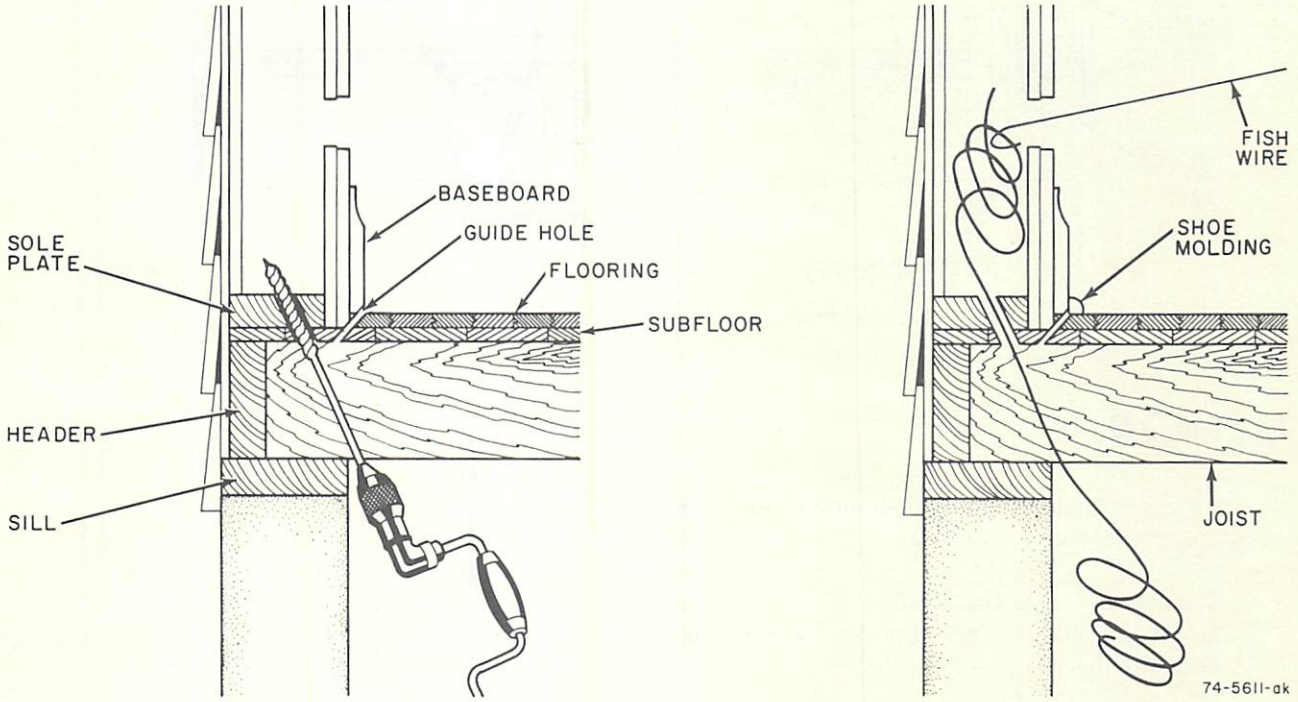


Fig. 37–Gaining Access to Outside Wall From Basement.

METHOD 2

If it *is not* possible to drill into an outside wall from below, use the following procedure and Fig. 38.

Use the flexible bit to drill down from the mounting hole through the sole plate and floorboards. Connect wires to bit and pull wires up through the wall.

CAUTION: Be sure that the flexible bit enters the floorboards at the proper angle so it will emerge in the right place. Before drilling a hole, check area the bit will cross and emerge for pipes, conduit, or wiring.

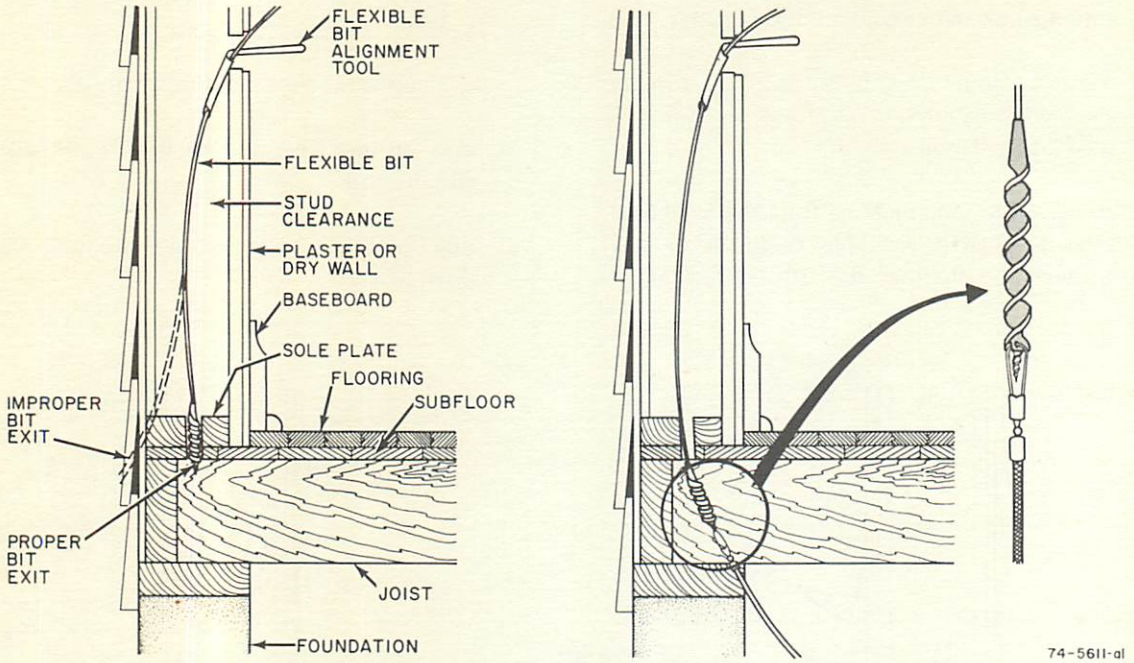


Fig. 38–Proper and Improper Use of Flexible Bit.

METHOD 3

If it *is not* possible to drill into an outside wall from below, use the following procedure.

1. Remove the baseboard and drill through the plaster into the wall. Also drill down through the floor into the basement (Fig. 39).

   a. Cut a channel in the plaster or back of baseboard to accept the wire.

   b. Run a fish wire through the wall from above. Signal wires can be pulled up from, or down to, the basement as desired.

   c. Pull the signal wires to or from the basement, routing it through the channel in the plaster or baseboard. Replace baseboard.

2. In a similar manner, the signal wire can be routed behind the baseboard to an interior wall and then to the basement.

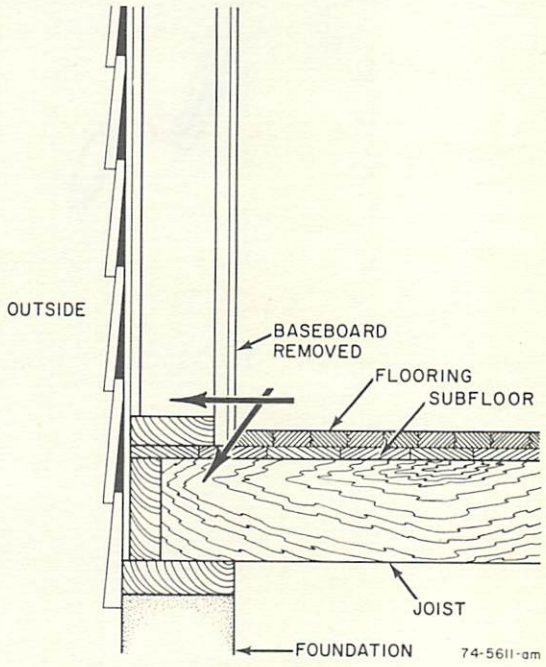


Fig. 39–Gaining Access to Outside Wall.

METHOD 4

Use the following procedure to run signal wires from a device, such as the control, through an interior wall to the basement. When possible, use the flexible bit (Fig. 38 or Fig. 42) since it is usually faster than separately drilling the hole and fishing the wire.

1. From the basement, drill a hole through the floor boards and sole plate into the wall (Fig. 40). Locate the hole in one of the following ways.

   a. Measure from some object such as conduit, pipe, heating duct, or electrical wires that go into the same wall.

   b. Remove the shoe molding from the baseboard. Drill a small locating hole through the floor at the selected location or drive a finishing nail through the floor as a guide. Use this hole as a guide to drill a hole from the basement into the wall.

   c. Replace shoe molding when finished.

2. From the basement, push a fish wire through the hole and into the wall (Fig. 41). At this point you may either–

   a. Hook a cord to the fish wire and pull it to the basement and then pull the signal wire from the basement up to the device being installed, or

   b. Hook the signal wire to the fish wire and pull it from the device location to the basement.

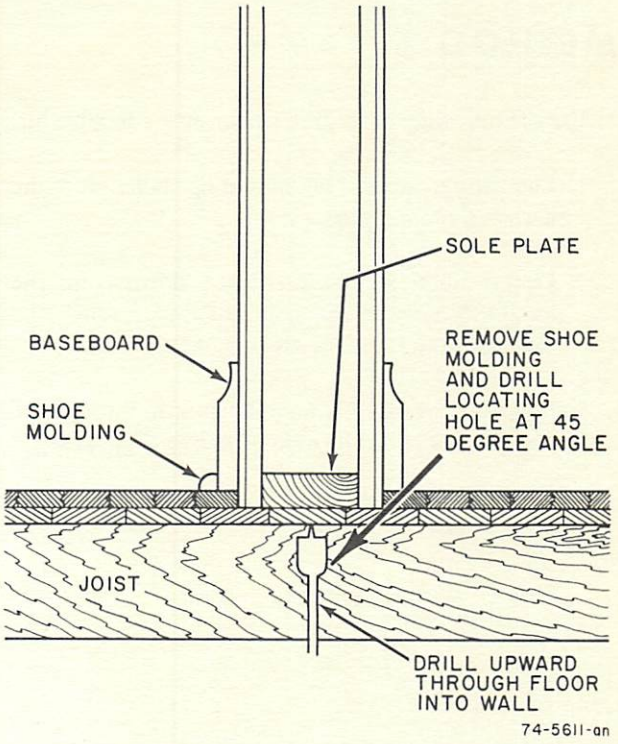


Fig. 40–Gaining Access to Interior Wall From Basement.

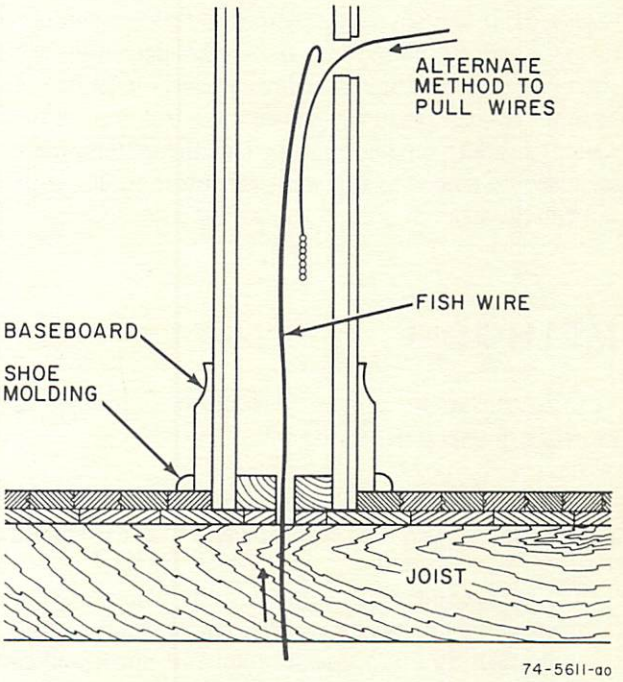


Fig. 41–Fishing Wire Through Wall to Basement.

METHOD 5

Use the following procedure when using a flexible bit.

1. Cut wiring access or mounting holes for the devices to be installed.

2. Direct the flexible bit straight down from the mounting hole in the wall and drill through the sole plate and floor boards (Fig. 42).

3. Connect wires to bit and pull wires up through the wall. Fish wire can be used if desired (Fig. 41).

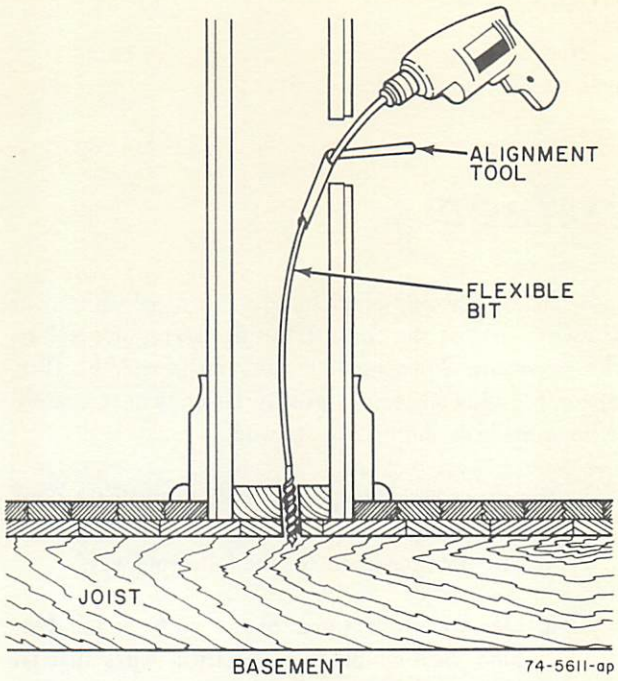


Fig. 42–Gaining Access to Wall Using Flexible Bit.

RUNNING WIRES TO ATTIC

In buildings where running wires through the basement is not practical, or the buildings have no basements, it may be necessary to run the wires through the attic. When used, heat or smoke detection will always be mounted on the ceiling, so wires must be run from the devices on the ceiling to a control unit on the wall. Depending on the building and the system, there may also be a need to run wires for intrusion detectors through the attic.

METHOD 1

When access to the attic is possible, the job is relatively simple. Refer to Fig. 43.

1. Locate the exact spot to enter the wall by carefully measuring from the end of the partition.

2. Drill straight down into the wall. There may be either one or two 2 x 4's (or metal plate) to drill through. Run tape measure down through wall to see if control unit can be reached (no braces, etc.).

3. From the attic, use the flexible bit or fish wire to pull the signal wires up through the wall, or push the signal wires from the attic through the hole into the wall space. Run the other end to the location of the ceiling mounted device.

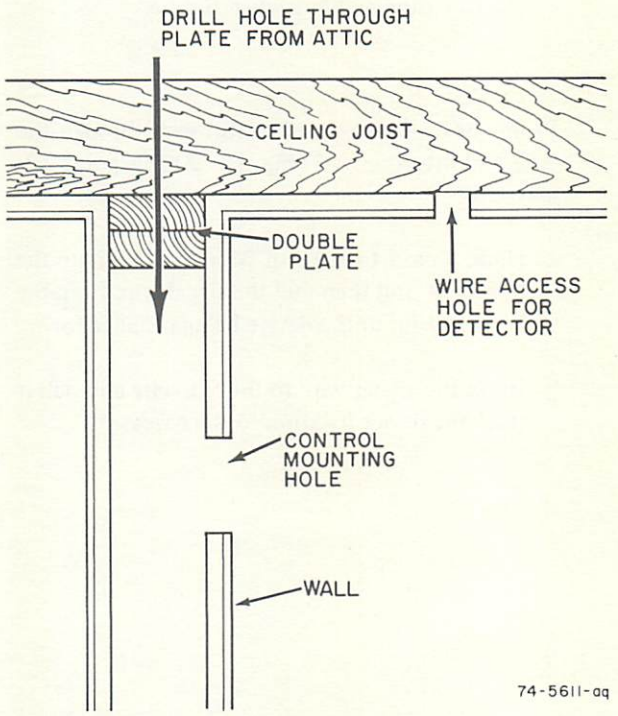


Fig. 43–Gaining Access to Interior Wall From the Attic.

METHOD 2

If access to the attic is not possible, or the attic floor is finished, the installation is more difficult.

1. Cut wiring access or mounting holes for the devices to be installed.

2. Direct the flexible bit straight up from the mounting hole in the wall and drill through the double plate (Fig. 44).

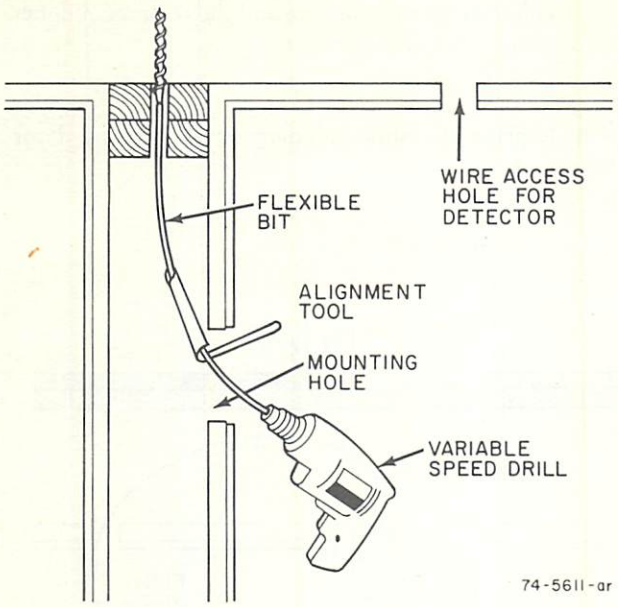


Fig. 44—Gaining Access to Attic From Below—Using Flexible Bit.

METHOD 3

The alternate method requires cutting a small hole in the upper corner where the wall meets the ceiling. This is particularly useful if the room has a cornice molding to conceal the holes or the vertical wire run can be made in a closet.

1. Cut wiring access or mounting holes at the desired locations for the devices to be installed.

2. Remove the cornice molding if present.

3. Cut small holes into the wall and ceiling spaces (Fig. 46).

4. Use two fish wires as shown in Fig. 46 to pull the signal wires through the ceiling and a fish chain in the wall.

5. Pull in the required number of signal wires.

6. Patch the holes and replace the molding if used.

3. Use two fish wires, one through the ceiling hole and one through the hole in the wall (Fig. 45).

4. Hook the two wires together and pull a fish wire or cord through to the ceiling hole.

5. Pull the signal wire through the ceiling and wall.

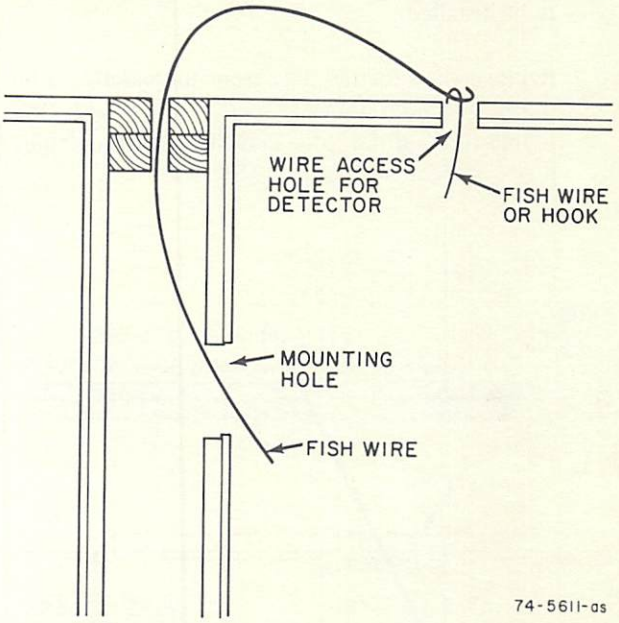


Fig. 45—Fishing Wire Without Access to the Attic.

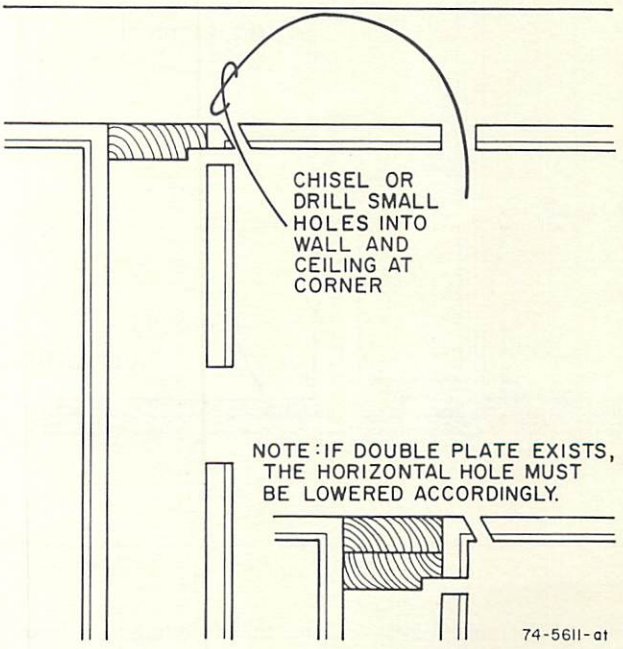


Fig. 46—Alternate Method for Wiring Ceiling Mounted Device.

RUNNING WIRES IN A TWO STORY FRAME BUILDING

METHOD 1

If the wire is to be run from an outside wall, or from an interior first floor wall with a second floor wall directly above it, proceed as indicated below. However, before using this method check ceiling wiring methods described previously (Fig. 44 and Fig. 46).

1. Cut wire access or mounting holes for the devices to be installed.

2. Remove the shoe molding from the baseboard on the second floor above the wall to be fished. Drill a hole through the floor and the plate (or double plate) of the first floor wall (Fig. 47).

3. From the second floor, run a short fish wire to the first floor wall opening (Fig. 48).

4. Use another fish wire through the ceiling mounting hole to catch the short fish wire.

5. Pull through the fish wire and the required number of signal wires.

6. Replace the shoe molding on the second floor wall.

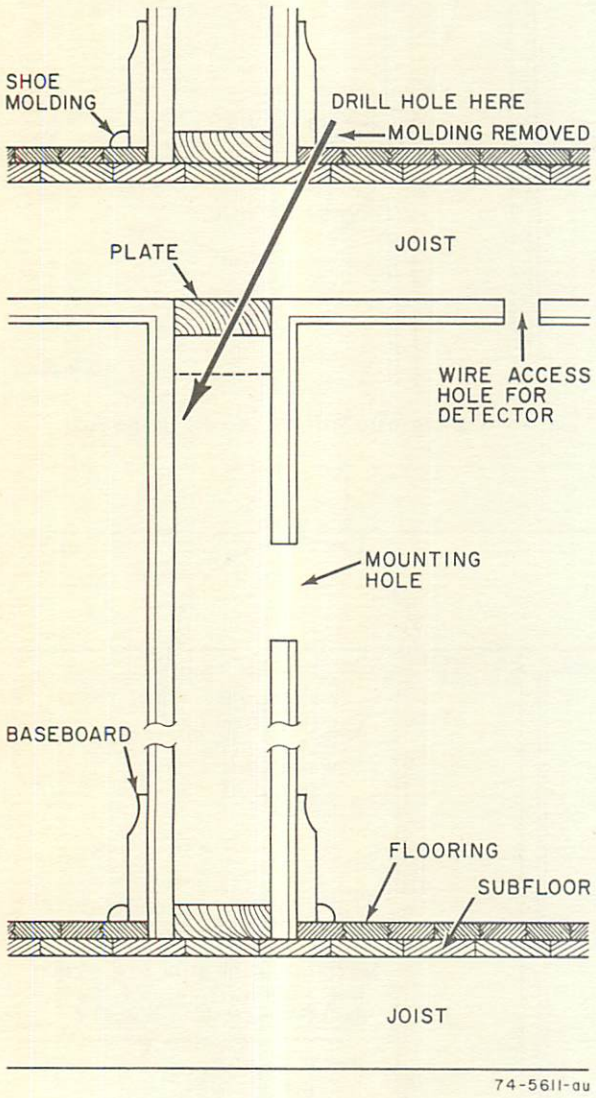


Fig. 47–Gaining Access to First Floor Ceiling in a Two Story Building.

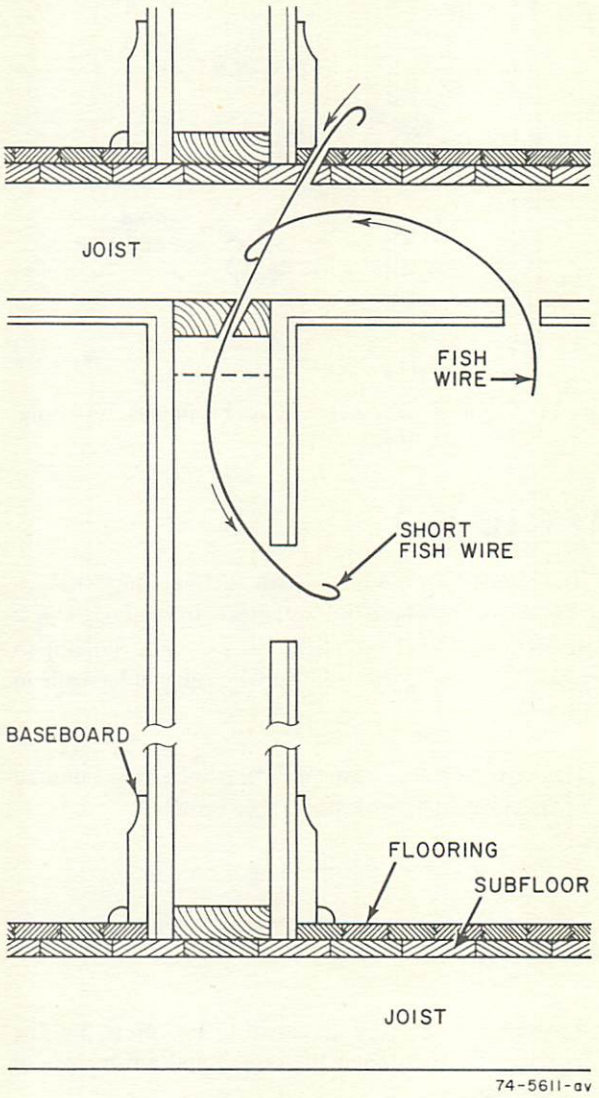


Fig. 48–Fishing Wire Through First Floor Ceiling in a Two Story Building.

METHOD 2

1. Cut wire access or mounting hole for device to be installed on second floor.

CAUTION: Take care to insure flexible bit drills straight down through walls or bit could cause needless damage to ceiling or first floor walls.

2. Use the flexible bit to drill down from the mounting hole through the second floor sole plate, and the double plate of the first floor wall (Fig. 49).

3. If bit can be reached from first floor, connect signal wires before removing bit. Otherwise, use fish wire as indicated in Fig. 50.

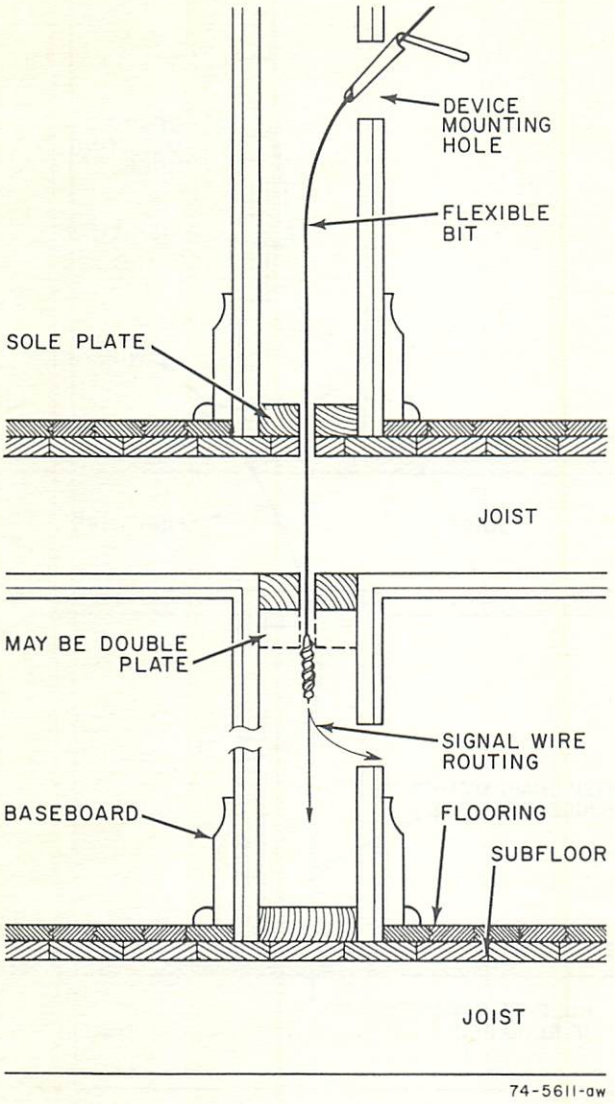


Fig. 49—Gaining Access From Second Floor Wall to First Floor Wall.

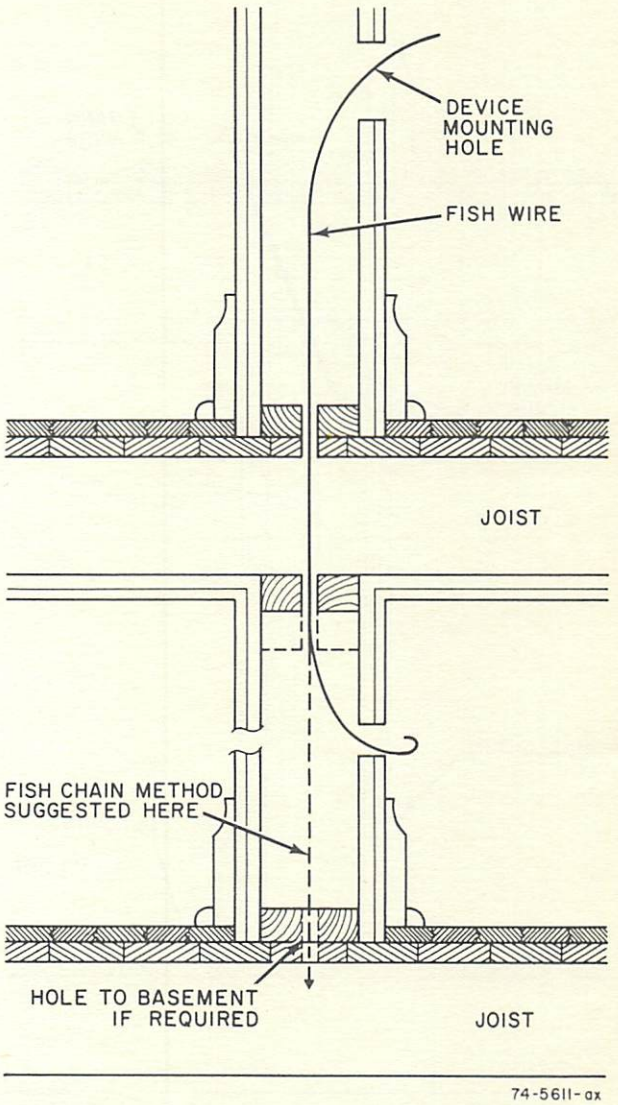


Fig. 50—Fishing Wire From Second Floor Wall Through First Floor Wall.

METHOD 3

1. Remove the baseboard from the second floor wall.

2. Drill two holes at the points indicated in Fig. 51.

3. Cut a channel in the plaster or wallboard between the two holes for the signal wires.

4. Wire the second floor wall using a fish chain from the mounting location of the device on the wall.

5. Wire the first floor wall (Fig. 52).

6. Pull in the required number of wires.

7. Replace the second floor baseboard.

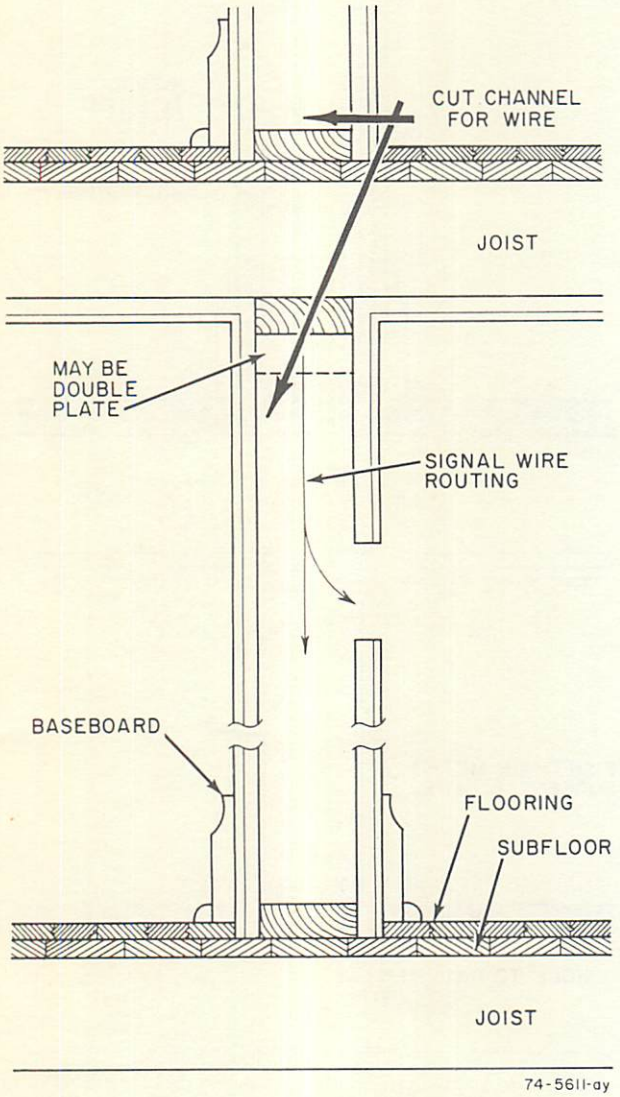


Fig. 51–Running Wire Through Plaster Behind Baseboard.

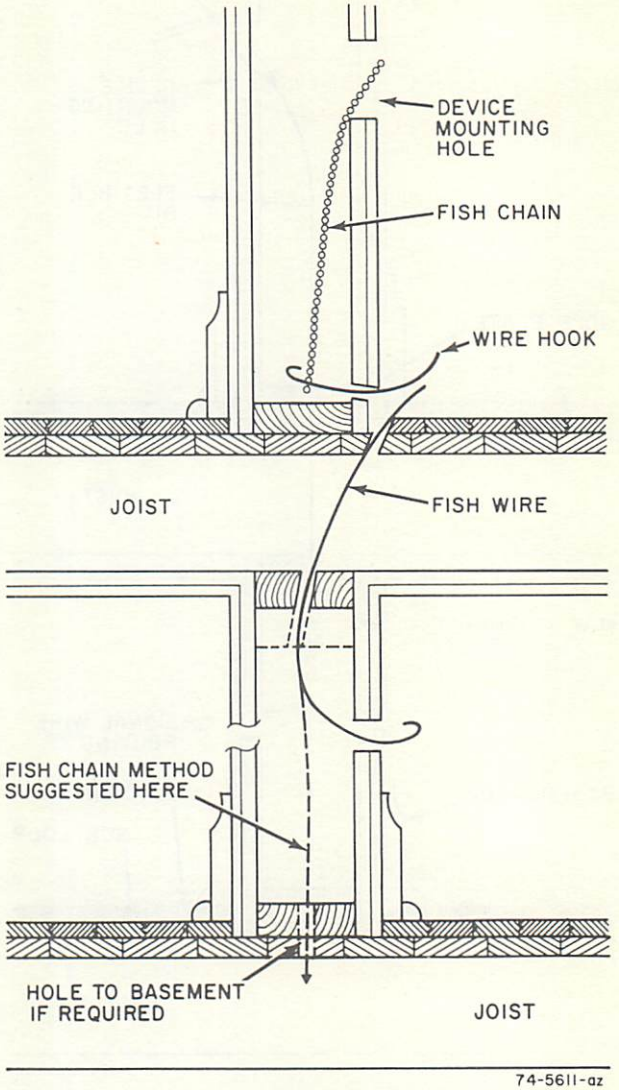


Fig. 52–Fishing Wire From Second Floor Wall Through First Floor Wall.

RUNNING WIRES IN A MULTI-STORY FRAME BUILDING

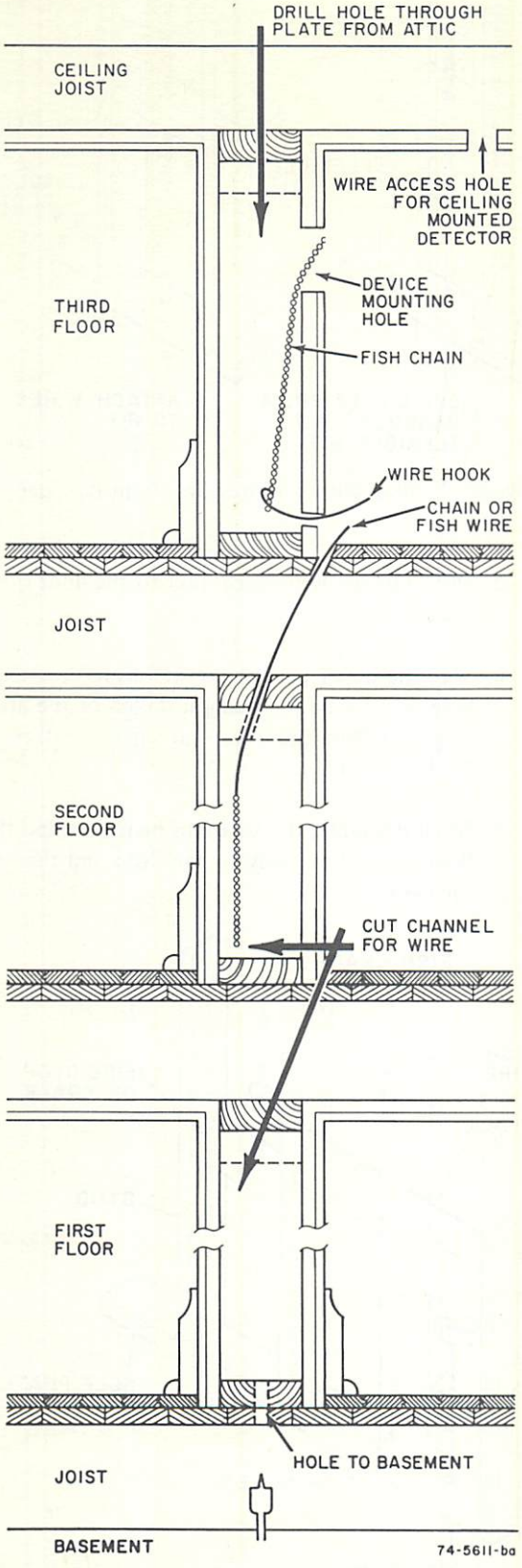


Fig. 53—Running Wires Through Walls of Multi-Story Frame Buildings.

If it is not possible to use runways or shafts in the building, use the following procedure.

1. Refer to Fig. 53 which illustrates a daisy chain method of going from one floor to another through interior walls.

2. When possible a flexible bit should be used since the wires can be attached to it and pull through the walls. This procedure eliminates the use of a fish wire.

SPECIAL PROBLEMS

FIRE STOPS (BRACE OR BRIDGING)

Braces or fire stops in many frame walls make it difficult to fish wires through them. Fig. 54 shows how braces are typically installed. When encountering this type of obstruction, use one of the following methods to work around it.

1. The flexible bit is intended specifically for this purpose. It is usually possible to route the bit into the mounting hole (Fig. 54) through the fire stop, and on to the basement or attic in one pass.

CAUTION: The presence of a fire stop makes it more difficult to control the angle of the flexible bit on the exit side of the fire stop.

2. If the brace on an interior wall is located fairly close to the floor (within three feet or so), it may be possible to drill a hole in it from the basement.

   a. Use a flexible bit and drill through the brace from the basement (or attic, if the obstruction happens to be close to the ceiling). See Fig. 55.

   b. Use the bit to pull the signal wires through the wall.

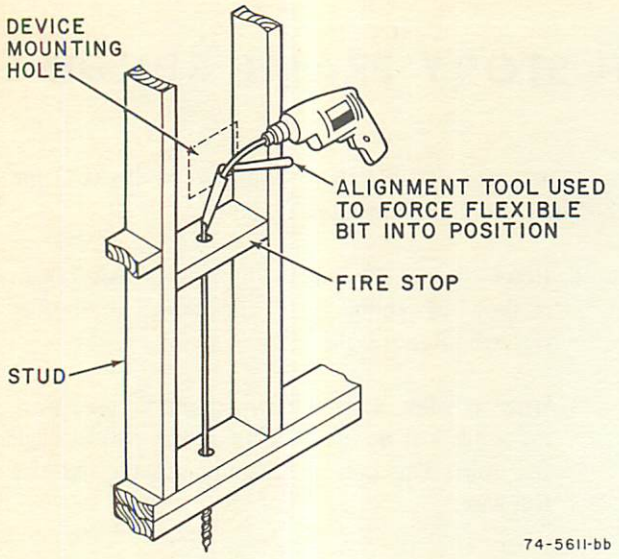


Fig. 54—Drilling Through Firestops.

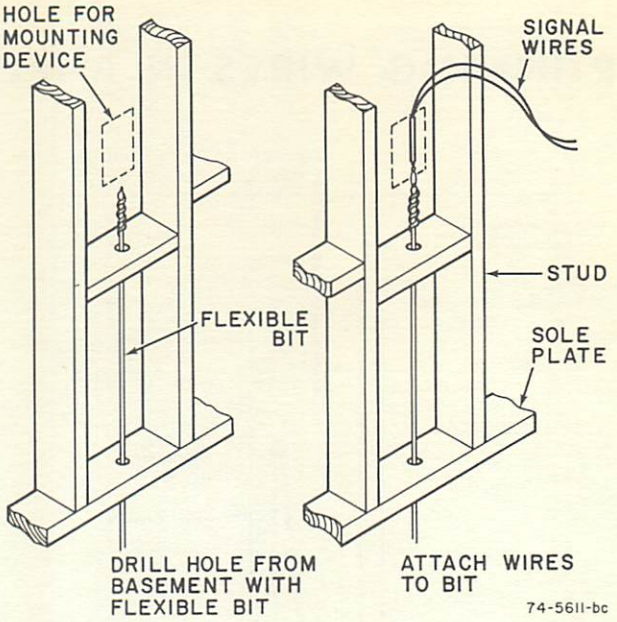


Fig. 55—Drilling Through Firestops From Basement.

3. If the brace or fire stop is close to a door, it may be possible to bring the wire out to the door and then continue below the obstruction.

   a. Remove the door stop (molding) on the side of the door frame closest to the wire run.

   b. Drill holes through the door frame and studs above and below the obstruction (Fig. 56).

   c. Chisel a channel in the door frame between the two holes to accept the wire.

   d. Drill into the wall space next to the door from the basement.

   e. Wire the upper part of the wall from the access hole for the device being installed or the attic (Fig. 57). Wire the lower part of the wall from the basement.

   f. When desirable, the wire can be run behind the door stop all the way to the floor and then to the basement

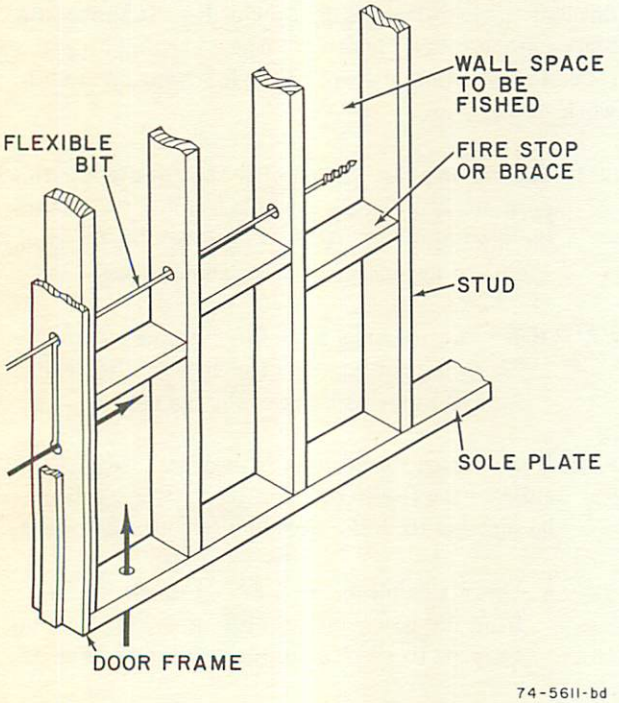


Fig. 56—Drilling Around Firestops.

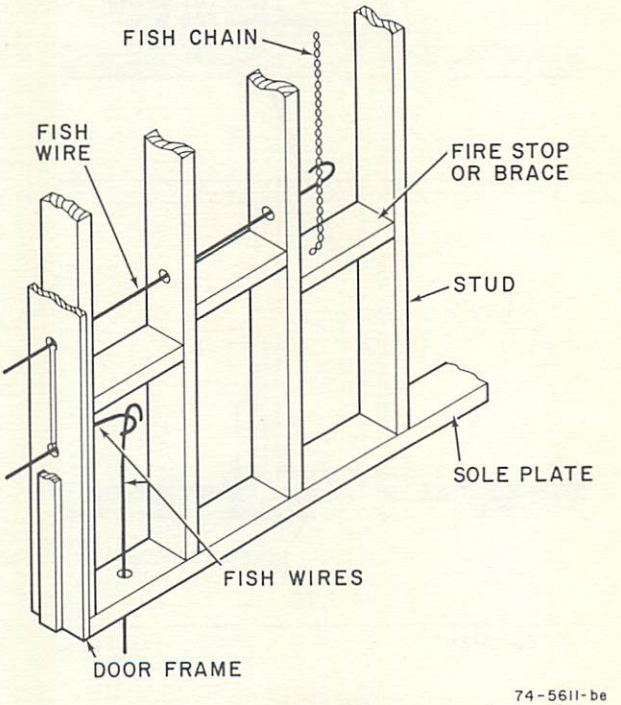


Fig. 57—Fishing Wire Around Firestops and Into Basement.

SOLID PARTITIONS

There are several types of partitions which allow quick and easy rearrangement of interior walls. Some of these partitions are solid and do not allow the routing of wires through them. However, the supporting frames are hollow and provide a good area for running system wires.

A helpful hint for routing wires in hollow supports is shown in Fig. 58. Fig. 59 shows the routing of wires in partition and door frames.

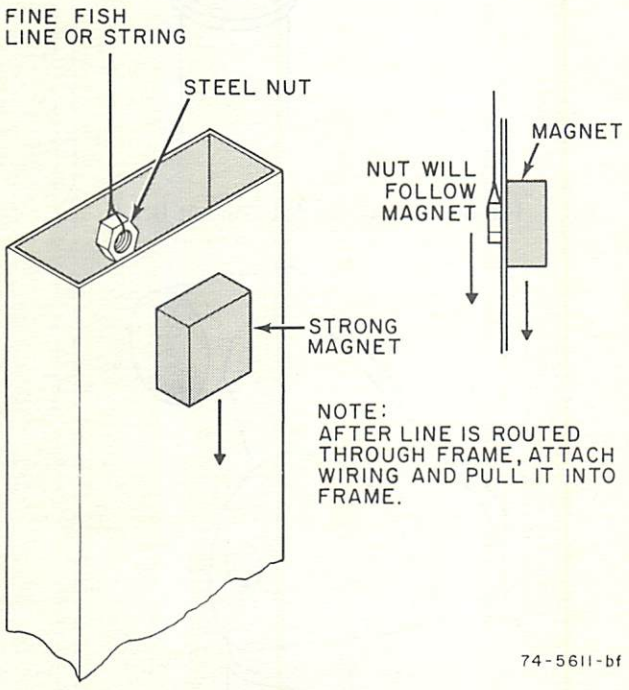


Fig. 58–Hint on How to Route Wiring Through Closed Metal Framing.

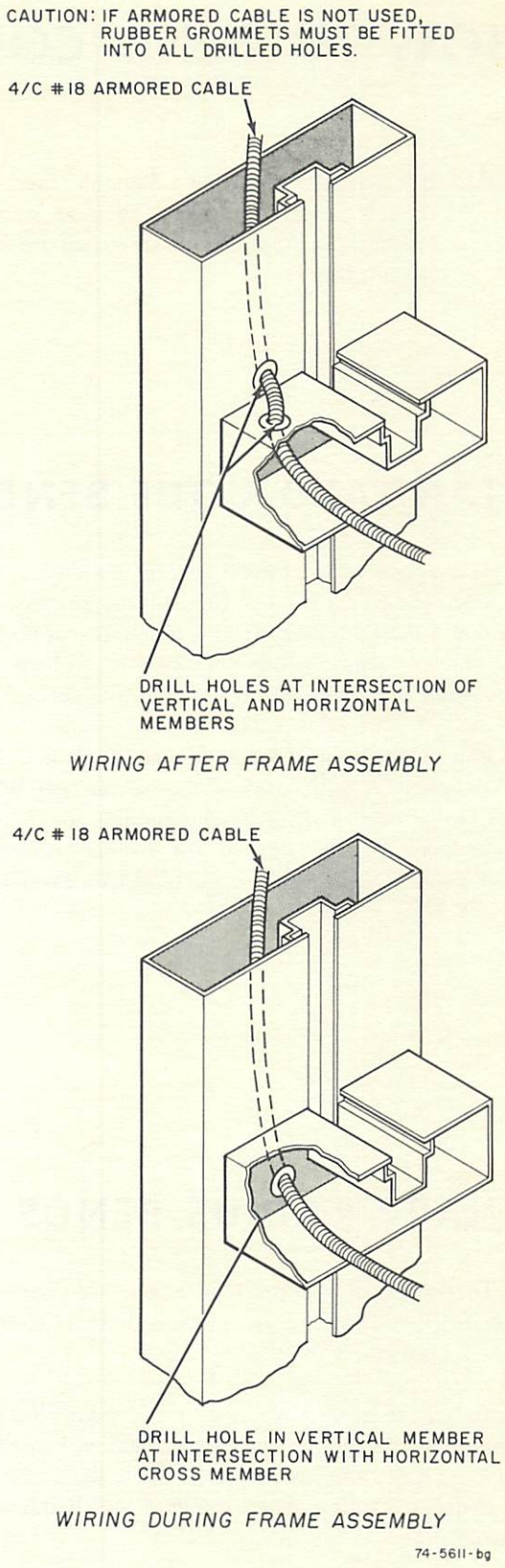


Fig. 59–Wire Routing in Partition or Door Frames.

HOW TO BEND CONDUIT

NOTE: It is recommended that a Republic Steel Corp. conduit bender or equal be used since the instructions listed below are based on such a conduit bender.

NOTE: The term "conduit" refers to EMT (Electrical Metallic Tubing) or thinwall tubing not rigid conduit.

STANDARD CODE BENDS

The groove of the bender (Fig. 60) conforms to the Standard Code radius. The sides of the groove help to minimize the flattening of the conduit as it is bent. The step on the bender allows foot pressure to help steady the bender and reduce effort required to make bend.

Proper alignment of bends is assured through the use of the arrows on the hook of the bender (Fig. 60) and the center lines marked on the conduit. By using the offset gage on the side of the bender, offsets and back-to-back bends can be made to exact measurements.

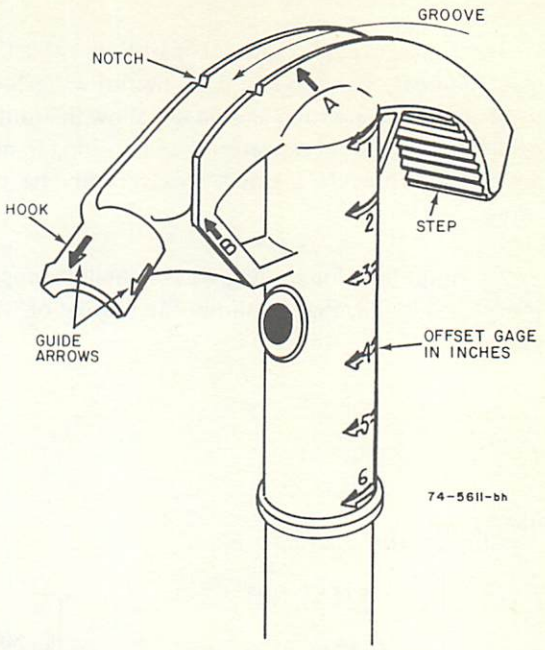


Fig. 60–Recommended Conduit Bender.

SHARP RADIUS BENDS

To make bends sharper than a Standard Code radius, the Hickey (Fig. 61) is recommended. This bender will produce just about any desired radius.

To ensure against kinking, the conduit should be "inched" through the Hickey and bent not more than 10^{o} at a time. The use of the Hickey should be limited to extreme situations where standard code bends are not possible.

NOTE: All wiring and conduit runs must be in accordance with local codes, ordinances and regulations.

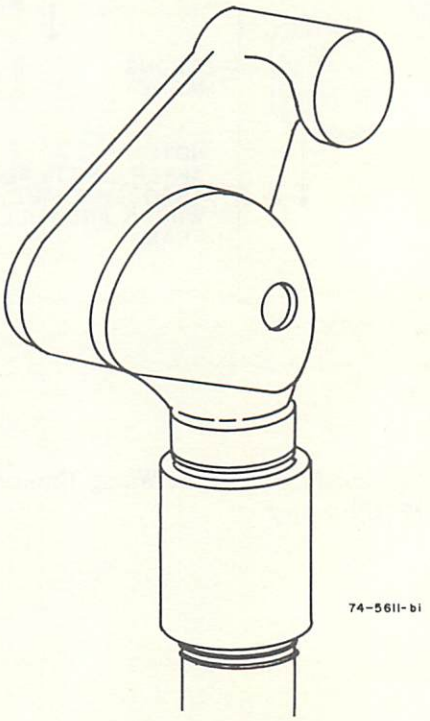


Fig. 61–Conduit Hickey.

WAYS TO MAKE BENDS

When working with the conduit on the floor (Fig. 62), apply pressure with one foot to the step of the bender, stand with the other foot on the conduit. A 90° bend is made by swinging the bender handle until the end of the conduit points straight up. A 45° bend is made by swinging the bender handle until the handle points straight up.

For saddles or offsets it may be easier to brace the bender handle on the floor and apply pressure on the conduit. When working with the bender reversed, pressure must be exerted on the conduit close enough to the bender so as to hold the conduit within the groove. This helps to prevent kinking and bends the conduit to an exact radius.

NOTE: Through the use of the guide arrows on the hook of the bender and the centerline marked on the conduit, bends can be kept in the correct plane.

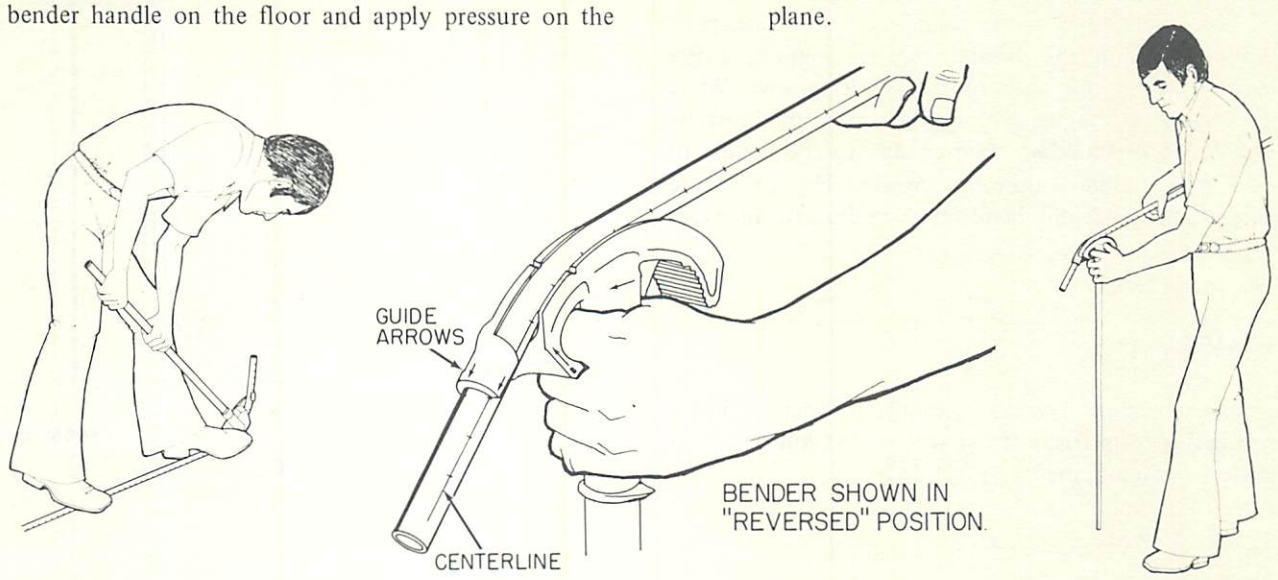


Fig. 62—Two Ways to Make Bends in Conduit.

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BENDER TAKE-UP OR RISE

Each size of conduit bender has a definite take-up or rise (Fig. 63). When working with conduit on the floor, a 90° bend is made by swinging the bender handle until the end of the conduit points straight up. A 45° bend is made by pulling until the bender handle points straight up.

When required, 45° and 90° preformed elbows are available in conduit size of 1 inch to 4 inches inclusive.

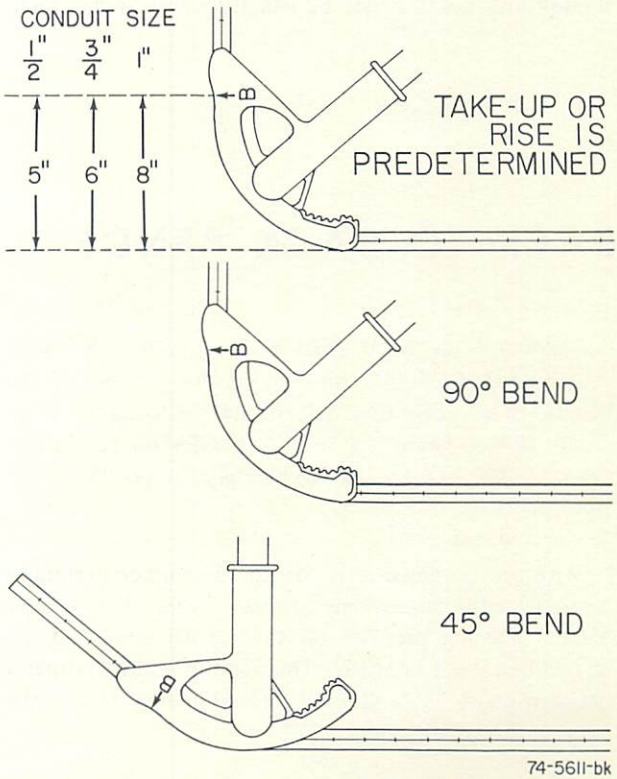


Fig. 63—Bender Take-Up or Rise — Standard Code Bends.

STUBS

Because the bender (Fig. 64) has a definite take-up (rise), the take-up must be kept in mind when setting the bender for a stub of any given height.

Subtract the take-up from the required stub height. This will give the point at which to place mark "B" of the bender from the end of the conduit. Make the bend and the stub will be exactly at the height required.

When working with the conduit on the floor, keep foot-pressure on the bender step to help hold the conduit within the walls of the bender groove. When working with the bender reversed, pressure must be exerted on the conduit close enough to the bender to hold the conduit within the groove. This procedure prevents kinking and bends the conduit to an exact radius.

EXAMPLE:

When bending 1/2-inch conduit, the bender has a standard take-up (rise) of five inches. If a stub of eleven inches is required, then:

11" - 5" = 6"

Set the bender mark "B" six inches from end of conduit and the stub will be exactly eleven inches high.

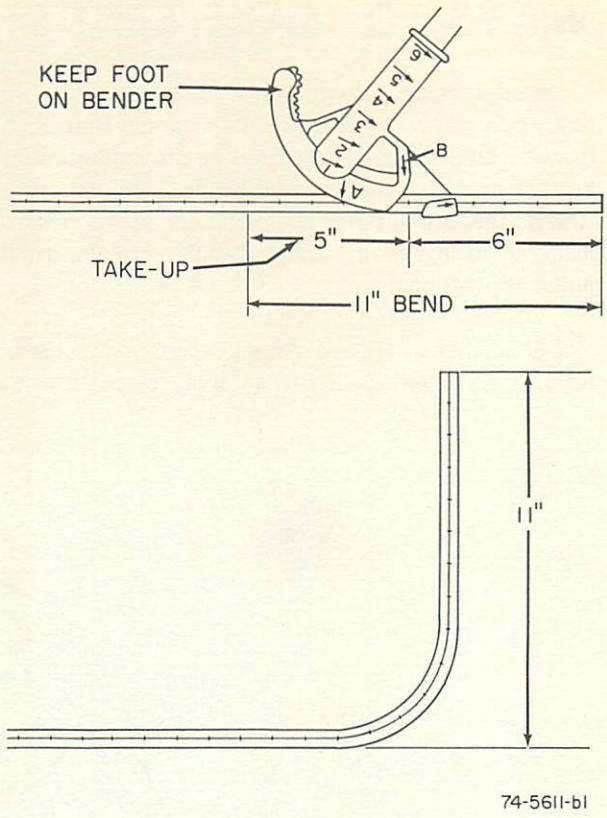


Fig. 64—Making a Conduit Stub.

BACK-TO-BACK BENDS

Make a stub bend (Fig. 65) at point "X" with centerline of conduit centered on the arrows of the bender hook (Fig. 65). Determine the distance from point "X" to point "Y". Place bender on conduit as shown and place mark "A" of bender at point "Y".

With the bender in this position, line up centerline of conduit with appropriate arrow. Swing the bender handle, keeping pressure on the bender step, and the second bend will be made. The conduit will fit properly between point "X" and point "Y" while maintaining the stubs in the same plane.

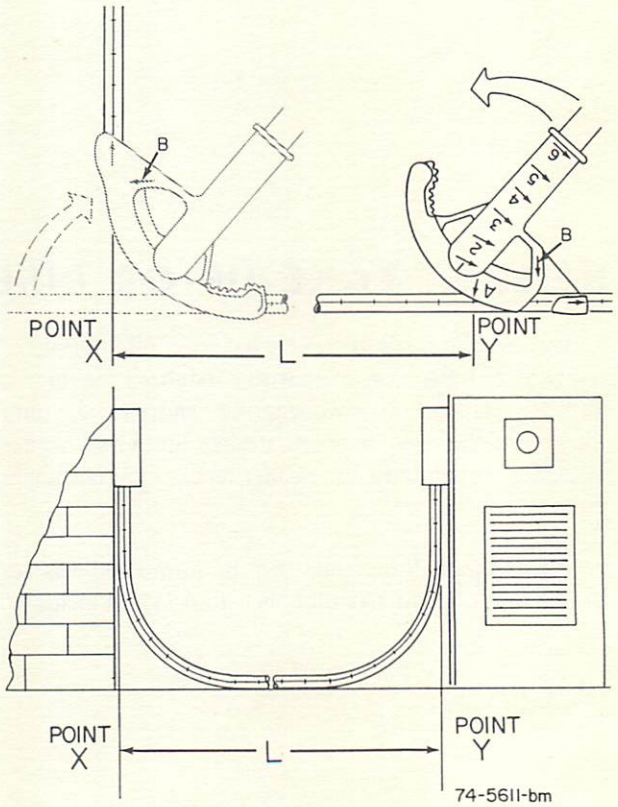


Fig. 65—Back-to-Back Bends.

OFFSETS

The quality of the finished job depends upon the skill of the workman making the offsets. A high degree of accuracy is made possible by the standard radius of the bender groove, the marking on the conduit, and the offset gage on the bender.

To make a four-inch offset proceed as follows (Refer also to Fig. 66 and Fig. 67):

Measure off the distance from the outlet box (or the end of the last length of conduit) to the starting point of the offset (point "X"). Line up arrows on the sides of the bender hook with centerline of the conduit. Place bender mark "B" above point "X" (Fig. 66) and make a 45° bend. Reverse the bender and slip the conduit through the hook until the lower part of the 45° bend lines up with the four inch mark of the offset gage on the side of the bender. Grasp the conduit and make the second 45° bend keeping arrow on the side of hook in line with centerline on conduit.

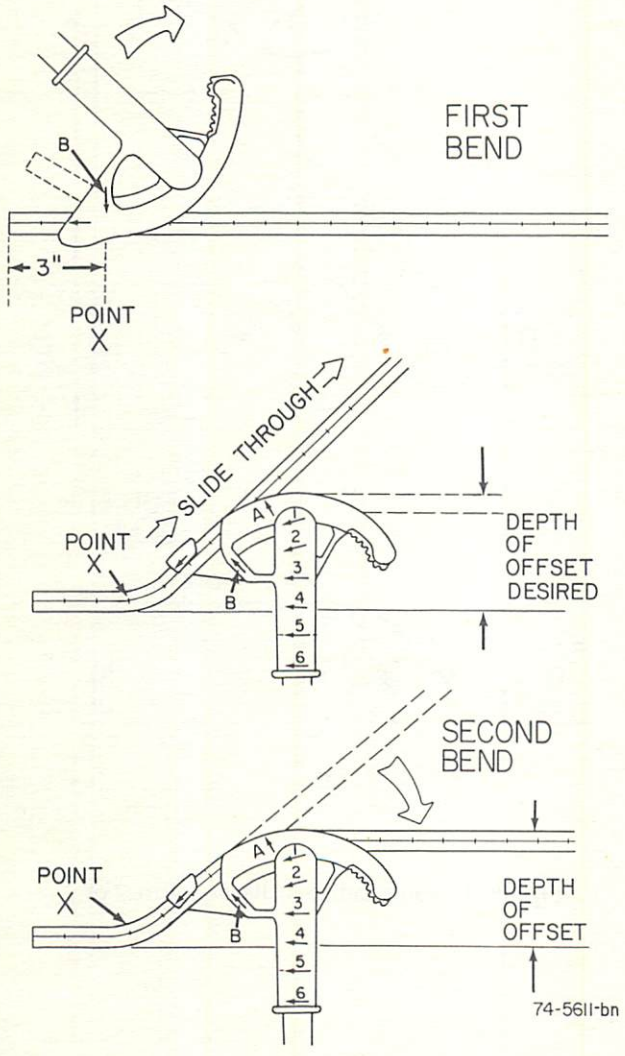


Fig. 66—Standard Conduit Offset.

TO SADDLE A BEAM

To make a four inch offset and a "kick-over" of a 4 x 4 beam, proceed as follows:

Measure off the distance from outlet box (or the end of the last length of conduit) to the beam (Fig. 67). From this distance, subtract or come back seven inches. The seven inch measurement is arrived at by using the first bending direction (take-up for 1/2-inch conduit) of five inches plus one-half the height of the object to be saddled, which in this case is a four inch beam, for a total of seven inches.

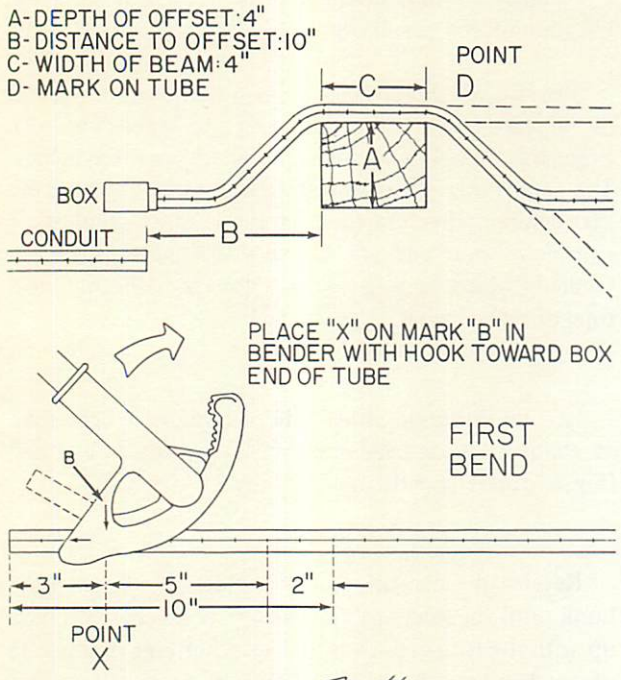
Line up arrow on either side of hook with centerline of conduit. Place bender mark "B" above point "X" (Fig. 67) and make the first 45° bend.

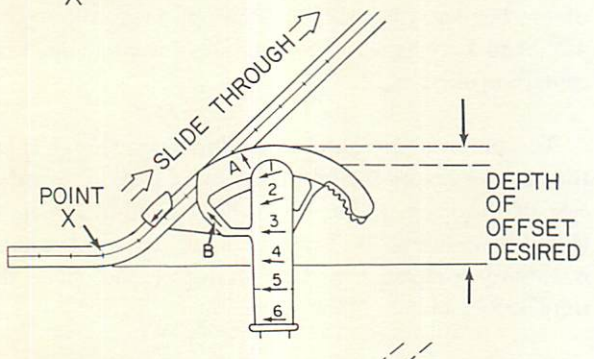
Reverse the bender and slip the conduit through the hook until the lower part of the 45° bend (Fig. 67) lines up with the four inch mark of the offset gage on the side of the bender. Grasp the conduit and make the second 45° bend keeping arrow on the side of hook in line with centerline on conduit.

To complete the saddle over the beam (Fig. 67) lay the conduit across the beam and mark conduit at other side of the beam (point "D"). Place conduit in bender (Fig. 68) so mark "B" is above point "D" and the hook is toward completed portion of offset and make the third 45° bend.

Reverse the bender and slip the conduit through the hook until the lower part of the 45° bend (Fig. 68) lines up with the four inch mark of the offset gage on the side of the bender. Grasp the conduit and make the final 45° bend keeping arrow on side of hook in line with centerline of conduit.

By following the procedure above, both legs of the saddle will be of even length. Keeping centerline of conduit in line with appropriate arrows on bender hook will assist in keeping the offsets lined up (in same plane).





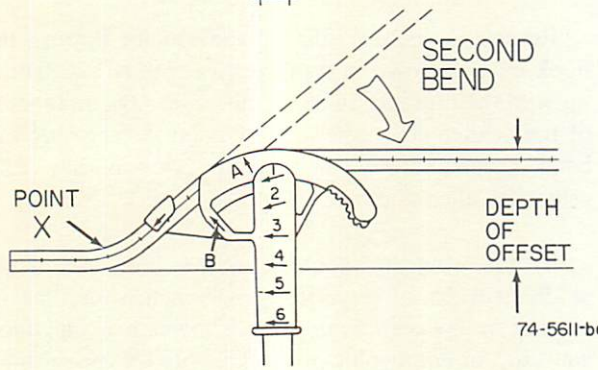
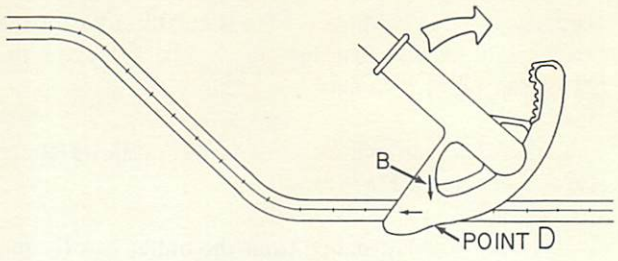
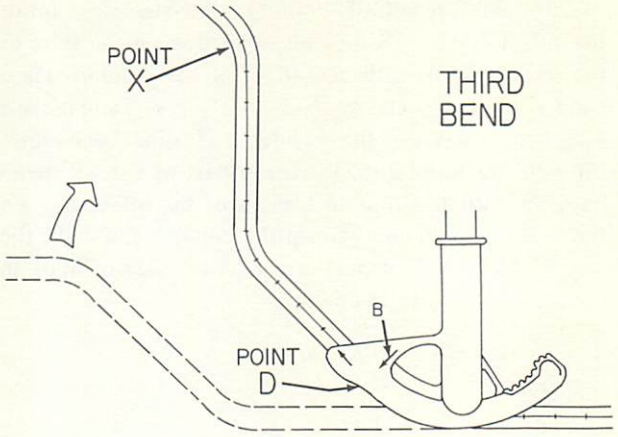
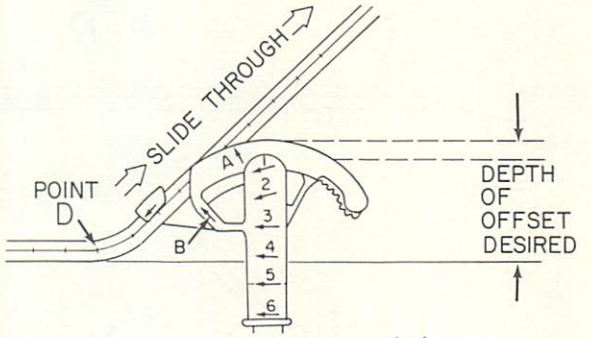


Fig. 67–Conduit Saddle of Beam – Part 1 of 2







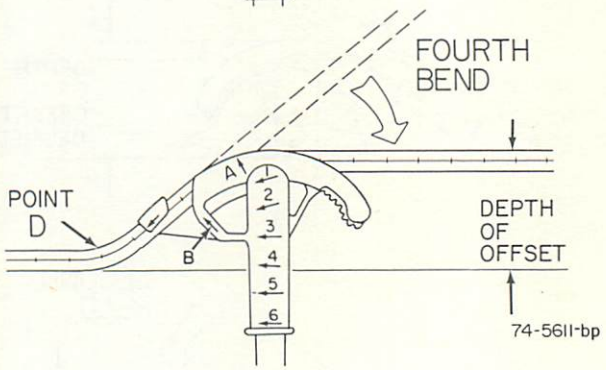


Fig. 68–Conduit Saddle of Beam – Part 2 of 2

SIMPLE SADDLE BENDS

Place the length of conduit across the object to be saddled (Fig. 69) and mark the following points:

"C" – Center point of saddle.

"X" – Twice the diameter of the object to be saddled, measured from point "C".

"Y" – Same distance as "X" but in opposite direction from point "C".

NOTE: When making bends, keep appropriate arrows on the bender hook aligned with conduit centerline. This action will keep saddle in proper alignment.

Place the conduit in the bender so that point "C" is at the notch of the bender and make a 45^{o} bend.

NOTE: For simple saddle bends smaller than one inch, make a slightly greater bend than 45^{o}.

Reverse the bender and slip the conduit through the bender hook until point "Y" is aligned with mark "B" on the bender. Grasp the conduit and make the first $22\text{-}1/2^{o}$ bend as shown. Remove the conduit from bender.

Slide the other end of the conduit through the bender hook until point "X" is aligned with mark "B" on the bender. Grasp the conduit and make the second $22\text{-}1/2^{o}$ bend as shown. Remove conduit from bender and check saddle alignment.

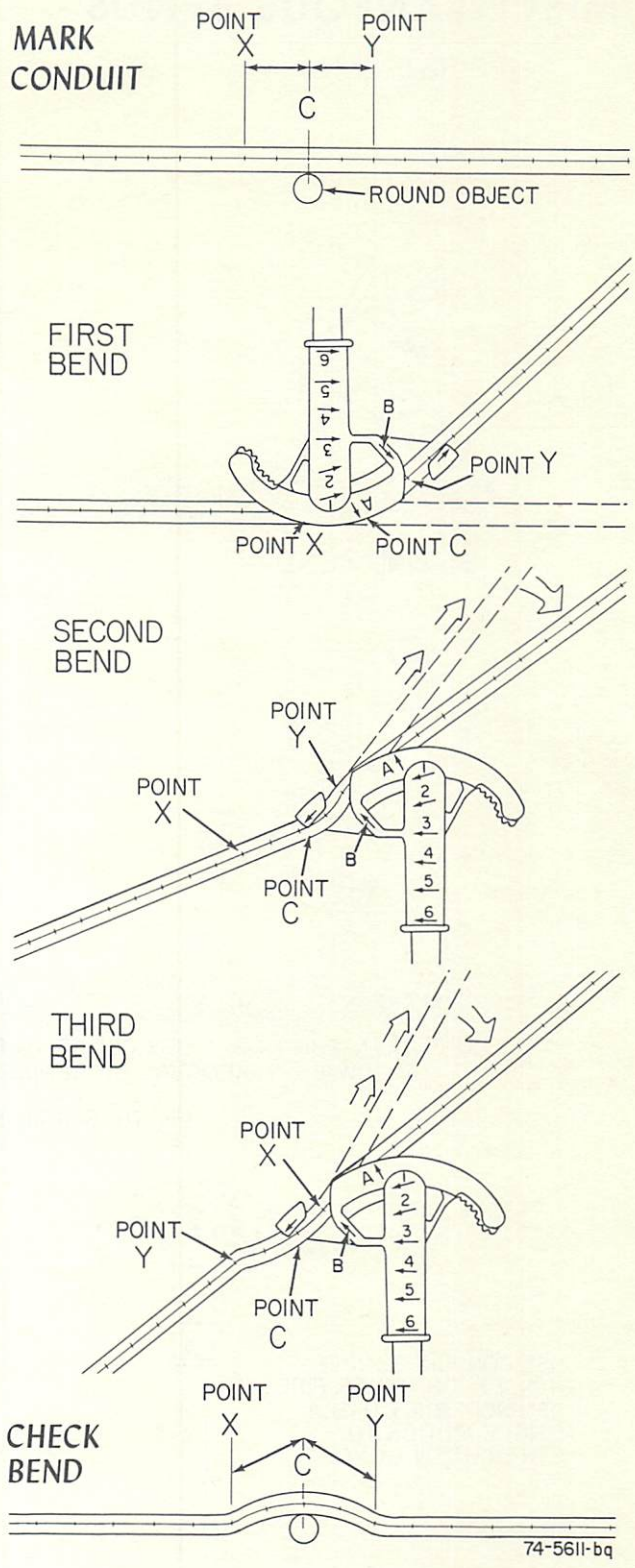


Fig. 69–Simple Saddle Bend.

MISCELLANEOUS BENDS

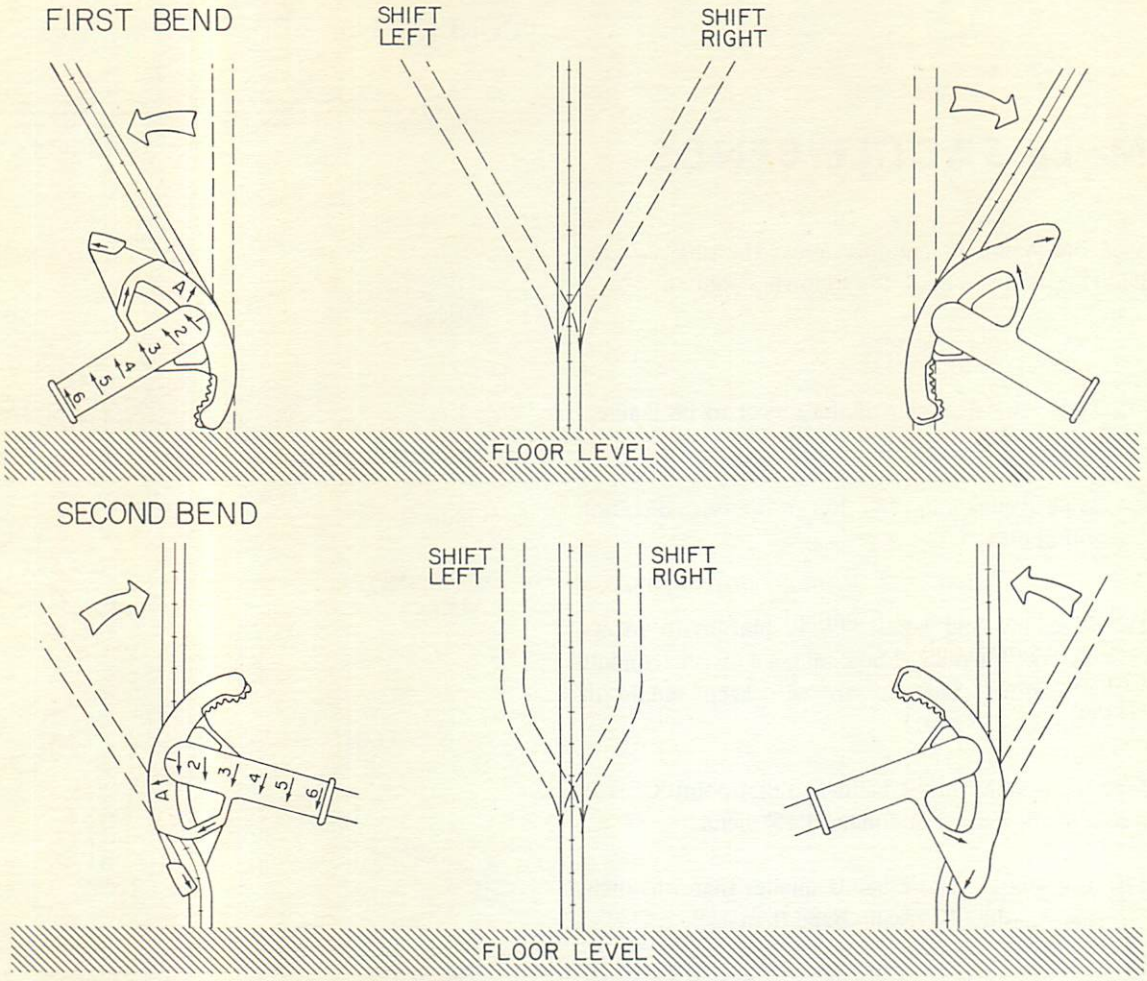


Fig. 70–Shifting Stubs – Right or Left.

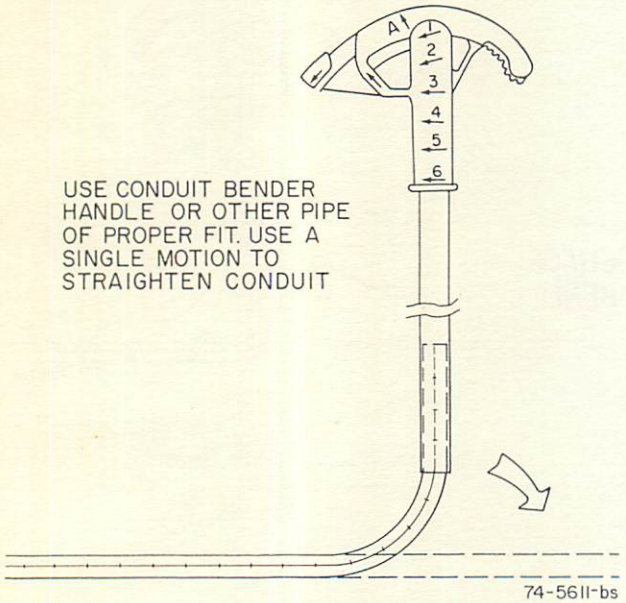


Fig. 71–Straightening Conduit.

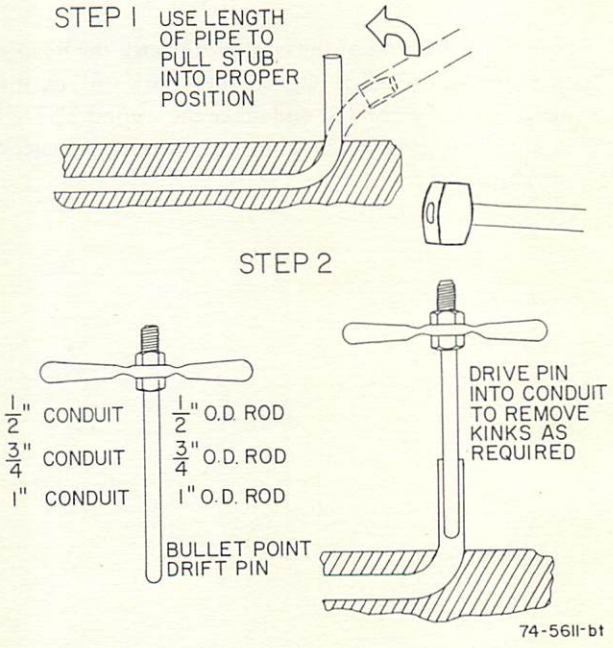


Fig. 72–Straightening Knocked Over Stubs.

SOLDERING AND WIRE SPLICING

SOLDER

Solder is an alloy of two or more metals—or, less frequently, a pure metal. Soldering with alloys or metals that melt below 800F is considered soft soldering.

The most commonly used solders are alloys of tin and lead.

The alloy containing 63% tin and 37% lead begins to melt at 361F.

The conductivity of solder is approximately 10% that of copper. Therefore, to minimize the additional electrical resistance, only a thin film of solder should be used to seal the solder connection. The added resistance of this thin film is negligible to the total resistance of the circuit. Mechanical connections are required for strength with soldering functioning as a seal.

FLUXES

Soldering flux is a chemically active compound used to promote the wetting of metals with solder. The soldering flux helps remove oxides from the metal surfaces and prevents oxidation of those surfaces and the solder during the soldering process.

Fluxes do not remove accumulated dirt, oil, grease and heavy oxides, and do not become part of the soldered connection. They are inactivated or removed after completion of the soldering operation. Fluxes are often categorized as corrosive and non-corrosive by the manufacturer.

CORROSIVE FLUXES

This type of flux is used on difficult to solder metals such as stainless steel and the like. Corrosive flux should not be used on electrical connections or near electronic components. The corrosive fluxes generally leave a chemically active residue which must be completely removed immediately after the soldering has been completed.

Chloride type fluxes are extremely active and are used to remove oxides and tarnish from most common metals except for aluminum and magnesium. This type of flux is highly corrosive and thermally stable. Chloride flux residue must be immediately and carefully removed after soldering.

Organic type fluxes are good for removing oxides and tarnish through a milder corrosive action than chloride fluxes. They are thermally stable but decompose rapidly at soldering temperatures. However, their residue is still corrosive and must be removed after soldering.

NON-CORROSIVE FLUXES

This type of flux (rosin base) is recommended for use when soldering electrical connections or electronic components. They are available in varying degrees of activation (cleaning ability) to remove oxides and tarnish when activated by soldering temperatures.

The flux residue, which is left after being brought up to soldering temperature, is chemically inactive and electrically non-conductive. However, any flux residue which has not been brought up to soldering temperatures may cause corrosion. Rosin base fluxes can be deactivated by heating to the appropriate temperatures. Solvents should not be used on deactivated rosin base fluxes.

NOTE: The tin-lead solders generally used today, are available in solid form or with a rosin core center. Use the least active flux that will satisfactorily clean the oxides from the surfaces being soldered.

ELECTRIC SOLDERING IRONS

An electric soldering iron contains a heating coil, usually of nichrome wire, which produces heat through its high resistance. The size and length of the wire determines the resistance of the heating element. The output is expressed in watts. More important than power output is efficiency, heat content and tip temperature. A well designed iron will provide the best balance in heat transfer between tip and heating elements.

Since the wires to be joined must be heated above the flow temperature of solder, it is important to select an iron that will attain the proper temperature in a fairly short time.

The metals commonly used for soldering tips are copper and copper alloys, plated or unplated. Copper has high heat conduction and good tinning properties, making it suitable for most soldering operations.

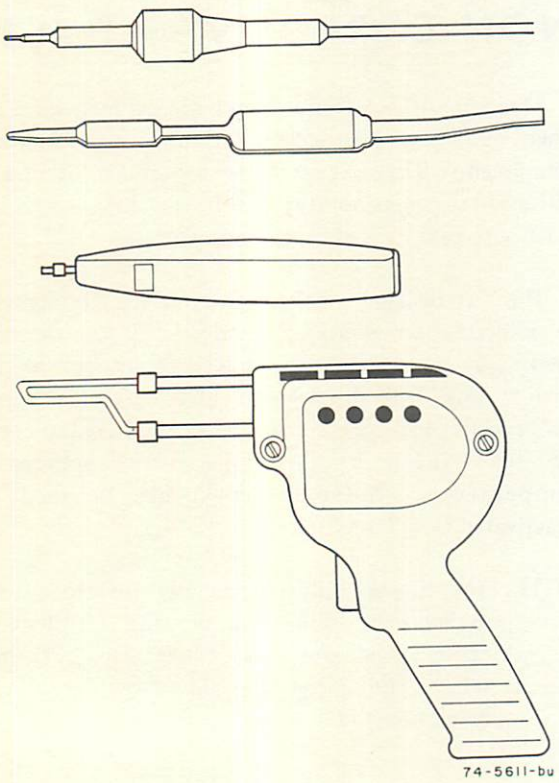


Fig. 73–Typical Soldering Irons.

DRESSING AND TINNING PURE COPPER AND COPPER ALLOY TIPS

NOTE: This is a shop procedure and should not be used in the field.

Copper and alloy tips are not tinned by the manufacturers but can be prepared by the following procedure.

1. Insert a clean tip into a core which is free from scale.

CAUTION: The tip must be bottomed in the barrel and secured in place.

2. Using a file, dress tip to remove oxides and pits.

3. Apply cored solder to the entire working surface as the iron is heating. The solder must flow evenly on the tip. If tinning is not complete, repeat steps 2 and 3 until satisfactory results are obtained. When the tip becomes dirty or discolored with use, it may be quickly restored by applying cored solder and wiping on a pad, brass brush, or wet sponge.

4. Store iron in holder during idling with a minimum amount of solder on the tip to reduce pitting.

DRESSING AND TINNING PLATED TIPS

New plated tips may have been tinned by the manufacturer. However, additional solder should be melted on the tip as the iron is heating. The care of plated tips differs from that of copper alloy tips in the following ways.

1. Plated tips should never be filed. Filing removes the thin protective plating and exposes the copper body, defeating the purpose of plating.

2. Avoid abuse of plated tips. Chipped or cracked plating will reduce tip life.

3. Plated tips should be stored at idling temperature with an excess of solder on the working surface.

4. If the tip cannot be tinned satisfactorily with rosin cored solder, remove the tip from the iron and replace it with a new one.

MAINTENANCE OF SOLDERING IRONS

Practically all of the maintenance associated with the use of electrically heated soldering irons is centered on the tip, since it is the tip that comes in contact with the work. Maintenance of irons and tips may be greatly reduced by observing the following precautions.

OVERHEATING OF TIPS

A tip will overheat with prolonged idling and/or with excess line voltage. Both problems will reduce tip and heating element life and cause scaling, carbonization of rosin fluxes and create a problem in keeping tips tinned.

TIP TINNING

The work surface of the tip should be kept well tinned. A well tinned tip will maintain efficient heat transfer from tip and reduce tip scaling.

GENERAL TIP CLEANING

If the tip is held in place by set screws, loosen the screws and remove and clean the tip. Then insert and remove the tip several times to remove scale from the holder. It may be necessary to ream the core. Screw in tips should be removed and the external thread brushed. The use of an antiseizing compound, such as silicone lubricant, may aid in reducing scale.

CLEANING OF COPPER OR COPPER ALLOY TIPS

When these tips are used continuously, they should be cleaned and tinned as frequently as necessary. The scale acts as an insulator and reduces the efficiency of the iron and should be removed from the tip as well as from the element of the iron.

CLEANING OF PLATED TIPS

These tips should be removed from the element for cleaning. Use care in handling them as damage to plating will greatly reduce tip life. Plated tips should never be filed. Cleaning (General Tip Cleaning) procedures are listed above. If an antiseizing compound is used, clean every two days or as often as experience dictates.

PREPARATION OF ELECTRICAL WIRES

Soldering insulated leadwires is not difficult if the wires are freshly stripped. Wire stripping should be accomplished without nicking or otherwise damaging the wire.

MECHANICAL WIRE CUTTING AND STRIPPING TOOLS

Mechanical type hand strippers, when in proper adjustment and when properly used, provide a clean strip that does not damage conductor strands. When wires are damaged in stripping, check the tool and cutters for:

- Proper hole for wire size being stripped.
- Proper adjustment of tool.
- Sharpness, nicks and burrs.

NOTE: To prevent damage to the conductors, do not use diagonal wire cutters (dykes) or linemen's pliers to strip wires.

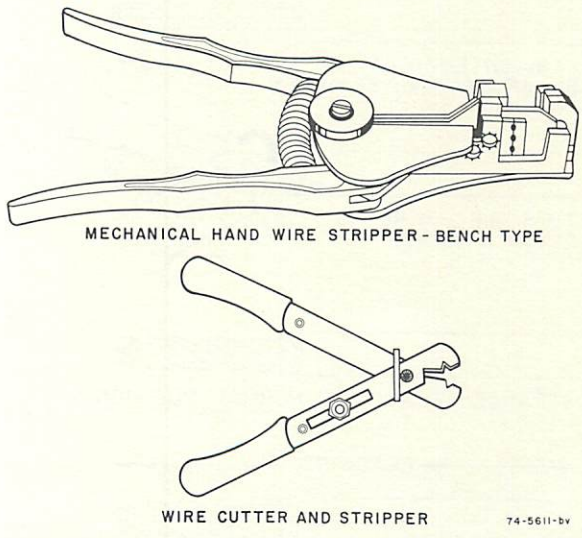


Fig. 74—Typical Hand Tools for Cutting and Stripping Wires.

BENDING TOOL

Bending and forming of component leads or wire conductors can be accomplished with a long nose pliers. Long nose pliers are good bending tools for component leads, provided the sharp edges of the jaws are covered. Component leads or wire conductors must not be nicked or ringed while they are being formed.

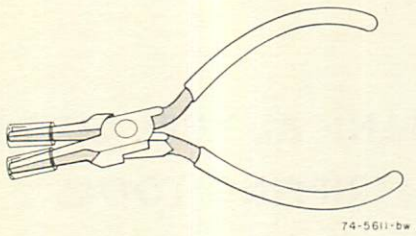


Fig. 75–Long Nose Pliers Covered with Tubing.

INSULATION REMOVAL-STRANDED WIRE

The insulation must be removed from the conductor to permit attachment by soldering and to ensure electrical continuity. The piece of the insulation to be removed from the conductor should be of sufficient length to allow the wire to be tinned, formed, and soldered to the terminal, or other conductor, with ease.

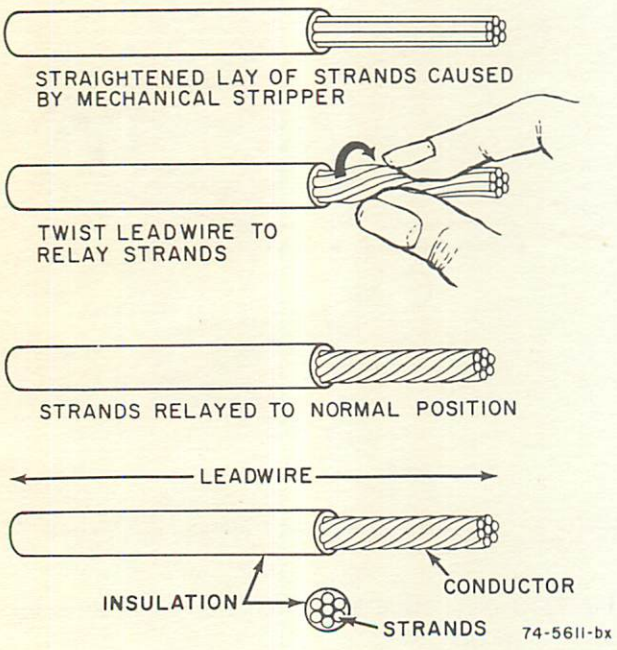


Fig. 76–Proper Method for Removing Insulation – Stranded Wire.

TINNING THE CONDUCTORS

Tinning the leadwires is a process of applying a thin coat of solder to the exposed surface of the stripped wire. Wires are tinned to hold the strands together to prevent fraying during handling and to improve their solderability. Tinning on wires should never be closer to the insulation than 1/32 inch. This provides a space to observe solder flow at the time the wire is terminated, and thus assists in control of solder wicking. Tinning can be accomplished by using a soldering iron and cored solder.

Tinning may be full tin (tin entire stripped end within 1/32 inch min. of the insulation) or a tip tin (tip of wire tinned approximately 1/8 inch to prevent fraying). Use the same type of solder for tinning that will be used for the final connection. Solder should be kept to a minimum and should not obscure the strands. The tinning time should be as short as possible.

If the conductor is heated for a long period of time, the solder may flow under the insulation. This action, which is called wicking, is defined as the undesirable capillary action of drawing solder along the wire strands and under the insulation. Solder on the conductor where flexing or stresses may occur will cause stiffness and possible breakage.

Tinning of conductors may be accomplished as follows:

1. Strip appropriate length of insulation from the wire.
2. Clean the excess solder from the tip of soldering iron.
3. Form a pool of solder on the tip. Lay the wire in this pool of solder.
4. As the wire is drawn across the tip, add cored solder onto the conductor.
5. Remove the wire from the tip and remove the residue flux.

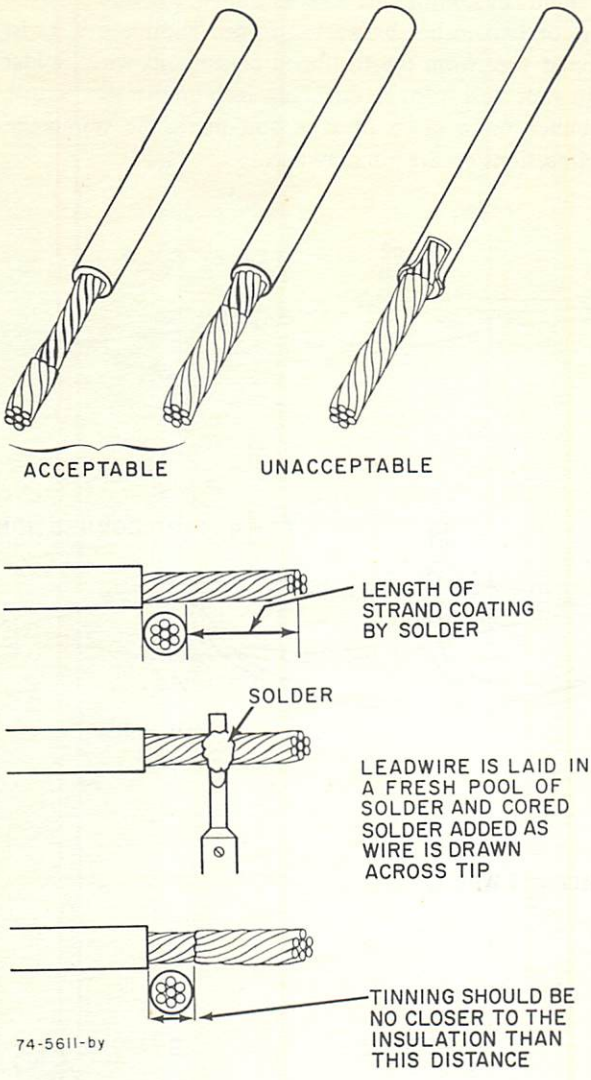


Fig. 77–Leadwire Tinning.

WIRING CONNECTIONS

Connecting together the ends of two separate wires is known as a "splice". Connecting a wire at right angles to a continuous wire is called a "tap". To make splices and taps strong, the connection must be done carefully.

A good connection must meet two requirements: 1) Wire must be bright and clean. 2) Connection must be tight, and secured with solder or solderless connectors and covered with tape.

SOLID WIRE

SPLICING WIRES TOGETHER

Remove one inch of insulation from each wire. Cross wires about 1/4 inch from insulation and make 6 to 8 turns. Remove excess wire, solder and tape.

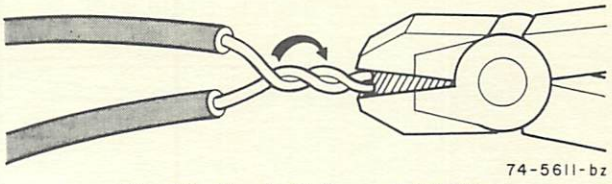


Fig. 78–Simple Splice – Solid Wire.

TAP SPLICE

Bare and clean the continuous wire. Bare and clean the tap wire. Wrap tap wire around continuous wire. Solder and tape.

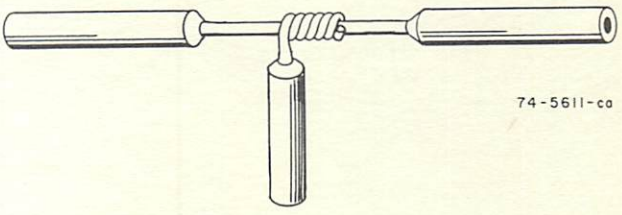


Fig. 79–Tap Splice – Solid Wire.

STRANDED WIRE

SIMPLE SPLICE

Strip insulation as shown in Fig. 80. Connect wire, solder.

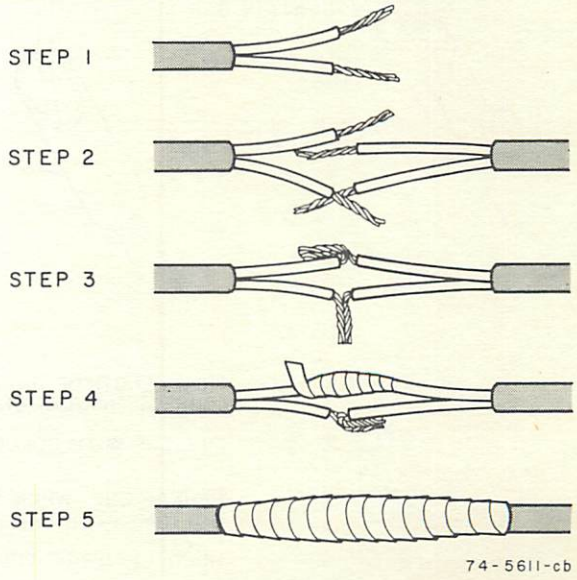


Fig. 80–Simple Splice – Stranded Wire.

TAP SPLICE

Strip, but do not cut continuous wire (Fig. 81). Always separate (offset) the strip points of the continuous wire.

Fold the continuous wire as shown. Provide between one or two inches between stripped conductors. Twist tinned wire from tap to tinned continuous wire. Solder and tape each connection. Flag each connection with a number on a piece of tape and mark the numbered connections on the job drawings.

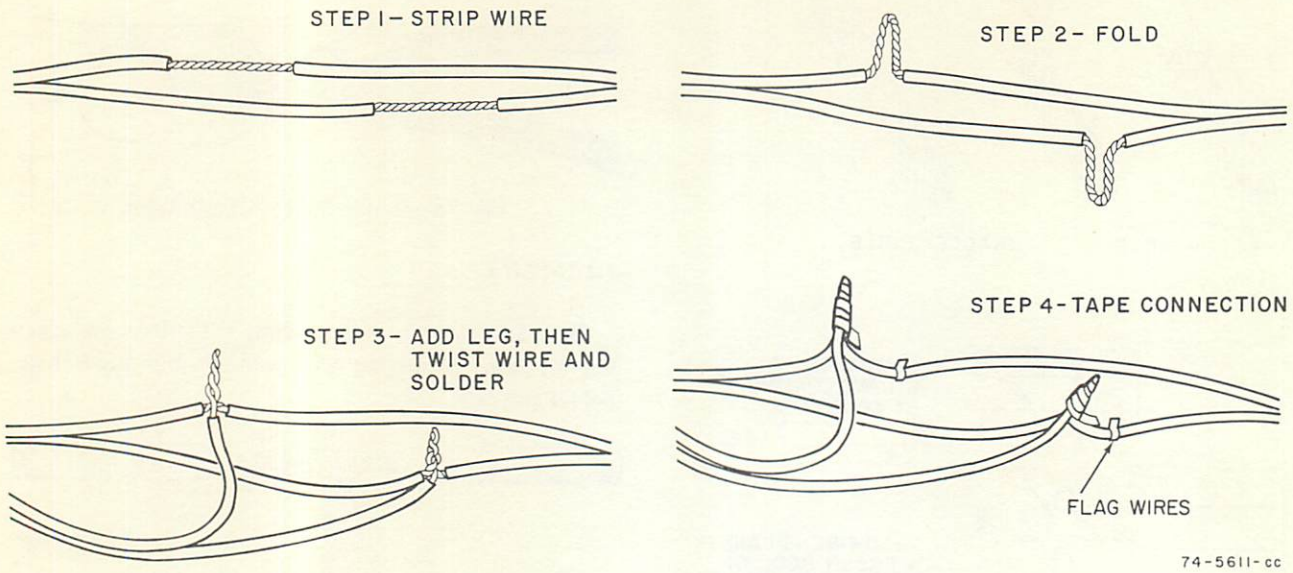
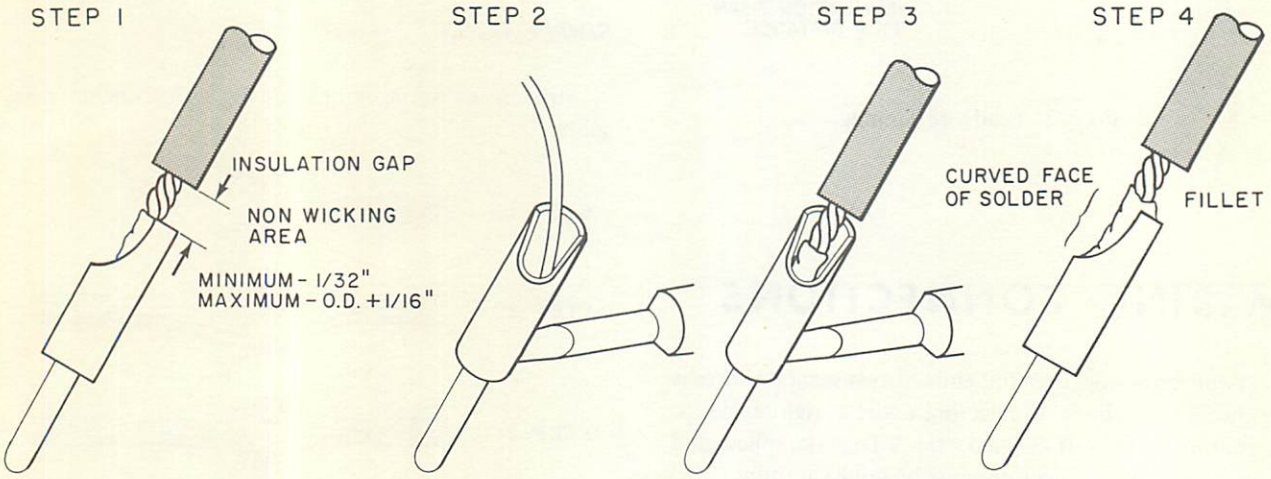


Fig. 81–Tap Splice – Stranded Wire.

CONNECTOR CUP



STEP 1	TRIM LENGTH OF TINNED LEADWIRE TO ALLOW FOR BOTTOMING. LEAVE CORRECT INSULATION GAP.
STEP 2	FILL CUP WITH SOLDER. MAKE SURE FLUX HAS BUBBLED TO SURFACE.
STEP 3	REHEAT CUP. WHEN SOLDER HAS LIQUIFIED, INSERT LEAD SLOWLY UNTIL IT BOTTOMS IN CUP AND IS AGAINST THE BACK SIDE.
STEP 4	HOLD LEADWIRE FIRMLY IN POSITION. REMOVE IRON AND ALLOW SOLDER TO COOL.

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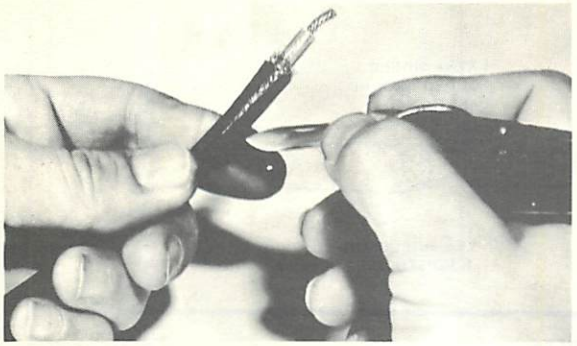
Fig. 82–Connector Cup Wiring.

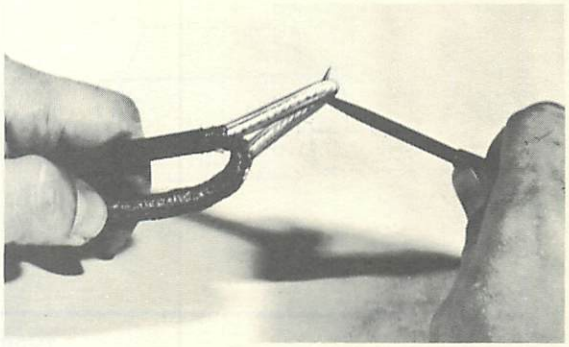
COAXIAL CABLE (SHIELDED CABLES)

SUGGESTED WIRE STRIPPING PROCEDURE

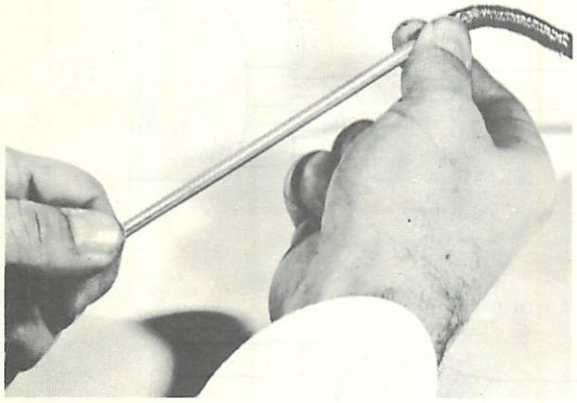
1. Carefully slit and pull off about two inches of outer insulation (View A).
2. Push shield back from end until loose on the inner insulation (View B).
3. Fold stripped portion back along cord (View C) and part the strands of the shield with a fingernail. Do not use a sharp-edged instrument or you may cut the strands or inner insulation. Pull out insulated conductor (a scratch awl or pencil point may be used for this as shown) and strip about 1/2-inch.
4. Twist light (View D) and tin (solder) the ends of the shield and conductor.



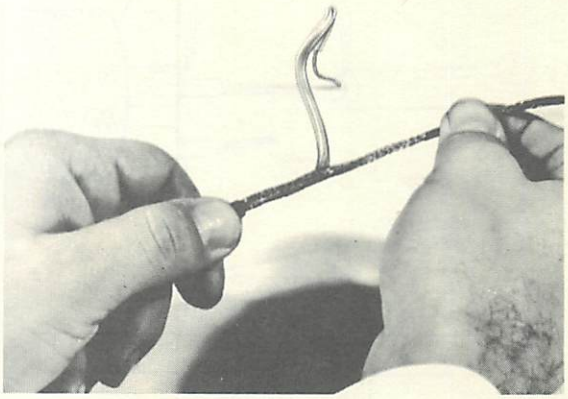
VIEW A



VIEW C



VIEW B



VIEW D

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Fig. 83–Suggested Wire Stripping Procedure – Coax.

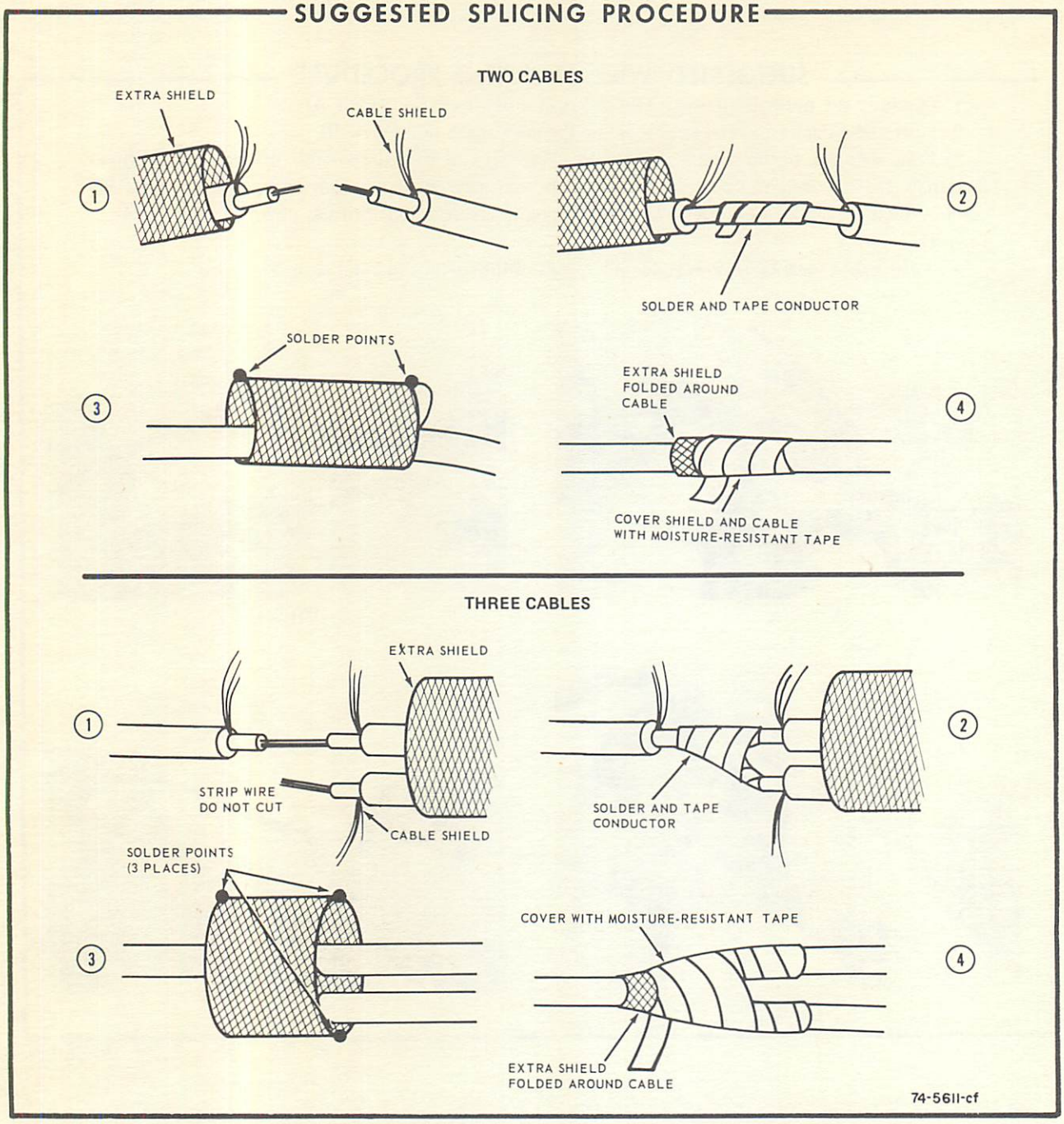


Fig. 84—Suggested Splicing Procedure – Coax.

SOLDERING PROCEDURES

The following general considerations are essential to obtain good solder connections.

1. Insure that parts to be joined are clean and stranded wire is twisted tight (Fig. 85, View A).

2. Insure that mechanical bond is secure. Inspect leads for damaged strands (Fig. 85, View B).

3. Keep insulation of wire out of the connection (Fig. 85, View C).

4. Position heat sinks, if required.

5. Check soldering iron for proper heat. Touch cored solder to tip and see that it flows freely.

6. Wipe soldering iron on pad to remove excess solder. The tinned soldering tip should be smooth, clean and bright.

7. Apply the flat of the tip to the joint on the appropriate side from the component or leadwire and obtain maximum contact between tip and connection (Fig. 85, View D). Heat the surfaces to above flow temperature of the solder. Be careful not to touch the wire insulation or nearby components with the iron.

8. Apply the cored solder (Fig. 85, View E). Solder should be melted on the surfaces to be soldered and not carried to the work on the iron. Apply only enough solder to complete the connection.

   Apply only enough solder to make a satisfactory solder connection. Solder is applied to the connection only when the temperature of the heated connection will readily melt the solder. It is normally applied near the area where the soldering iron tip contacts the connection, or to the heated metal of the connection.

NOTE: Solder should not be carried on the iron to the work, except in special instances. When it is necessary to carry solder on the iron, apply fresh solder to a clean, well tinned tip and make the transfer as quickly as possible to avoid contamination resulting from prolonged heating. When using wire or foil preforms in a connection, coat all surfaces of the preform with a thin coat of flux before heating.

9. Remove soldering iron with a sliding motion (Fig. 85, View F). Do not use liquids to cool a soldered connection. A freshly soldered joint must not be disturbed until the solder has completely solidified.

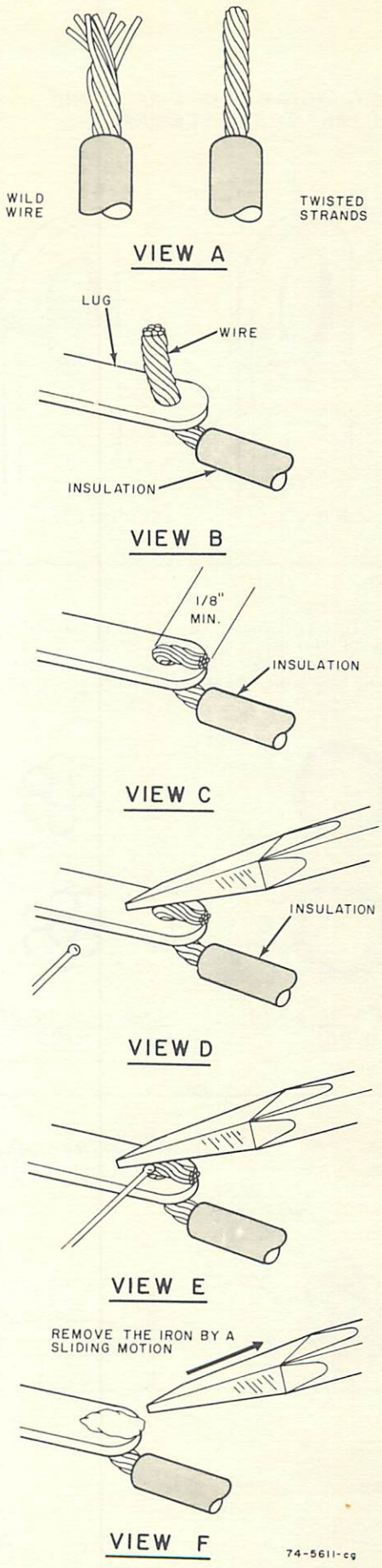
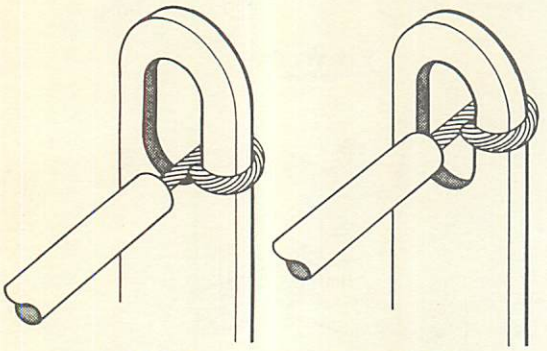


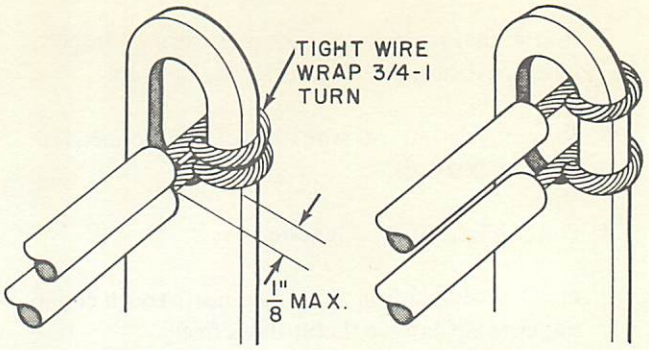
Fig. 85–General Soldering Technique.

● ALWAYS FORM THE FIRST WIRE AT THE LOWEST PART OF THE TERMINAL.



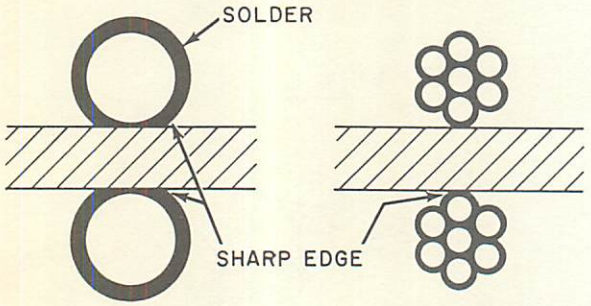
CORRECT INCORRECT

● FORM THE NEXT WIRE AS CLOSE TO THE LAST WIRE AS POSSIBLE. ALWAYS SOLDER LOWEST WIRE FIRST.



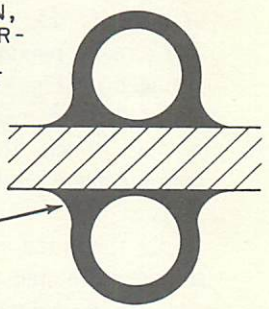
CORRECT INCORRECT

● COLD SOLDER JOINT HAS A GRAY, MUSHY APPEARANCE WITHOUT HIGH LUSTER. THIS IS CAUSED BY POOR HEATING OR HASTY WORK. PERMIT SOLDER TO FLOW, USE A HOTTER IRON, AND HOLD IRON IN CONTACT LONGER

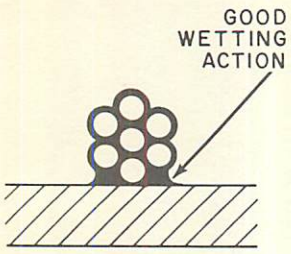


END VIEW OF SOLID WIRE *END VIEW OF STRANDED WIRE*

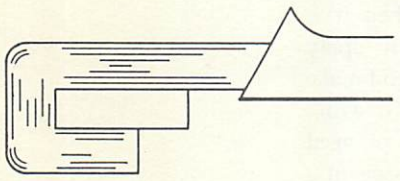
● EXCESS SOLDER IS REMOVED BY PLACING A CLEAN SOLDERING IRON ON THE CONNECTION, AND HEATING THE SOLDERED JOINT. REMOVE AND CLEAN THE IRON. REPEAT THE OPERATION SEVERAL TIMES REMOVING EXCESS SOLDER.



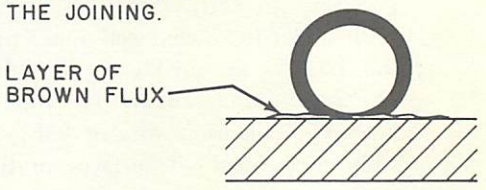
● GOOD SOLDER JOINT



● MELTED INSULATION – SOLDERING IRON TOO HOT



● A ROSIN JOINT IS CAUSED BY DIRT ON THE PART, EXCESSIVE FLUX, OR LOW HEAT THAT MAY LEAVE ROSIN FLUX BETWEEN PARTS IN THE JOINT. THIS MUST BE BOILED OUT SO SOLDER DOES ALL THE JOINING.



74-5611-ch

Fig. 86—Soldering Hints.

ADDITIONAL INFORMATION

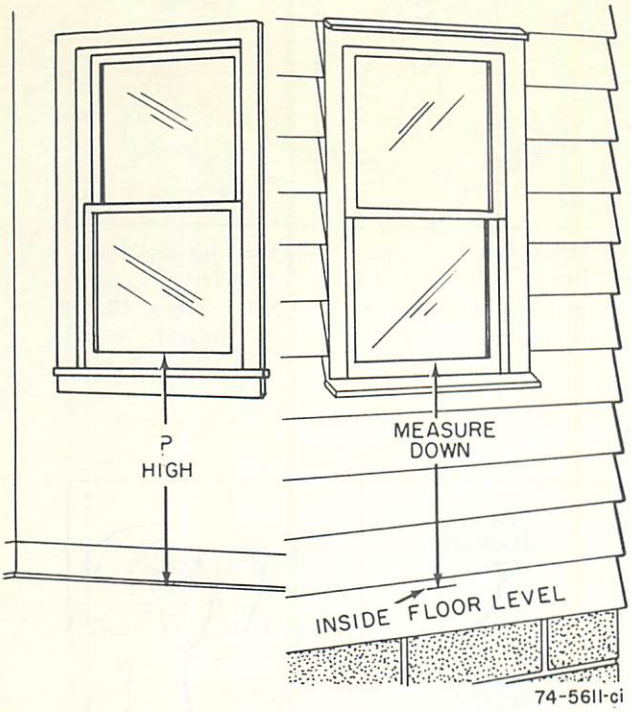


Fig. 87–Locating Floor Level From Outside the Building.

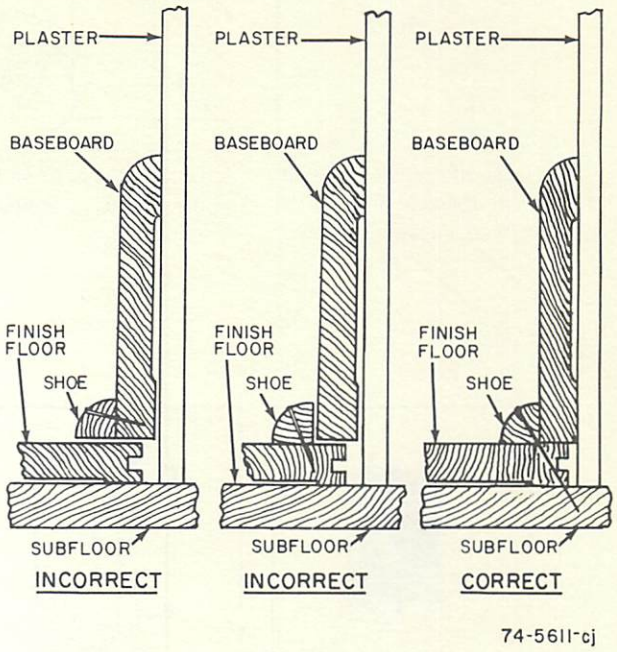


Fig. 88–Nailing Methods for Baseboards and Shoe Moldings.

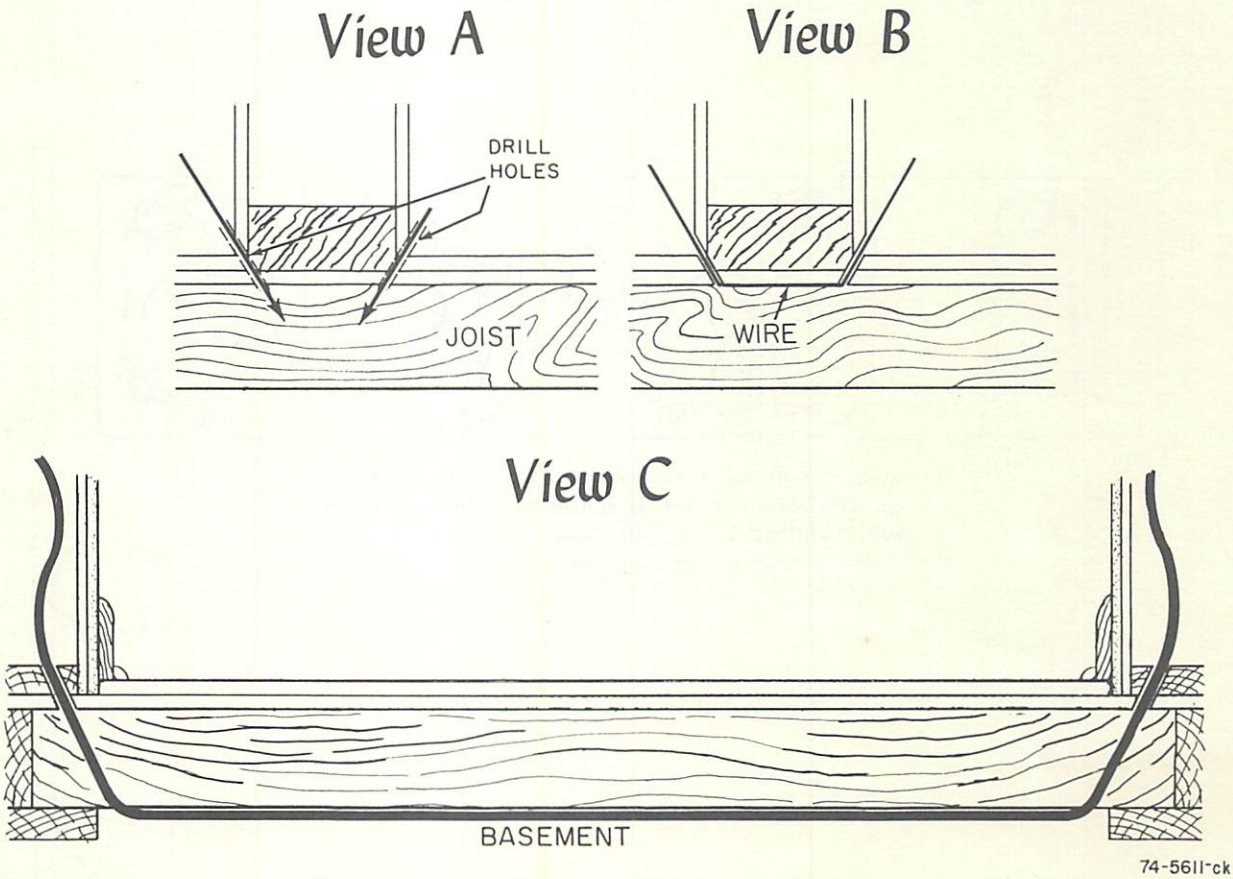
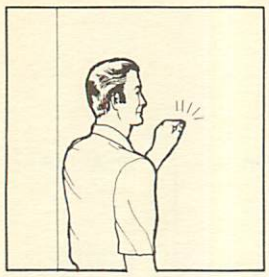
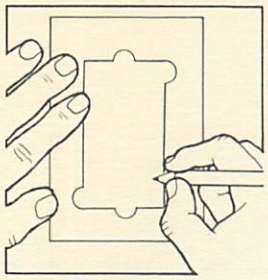


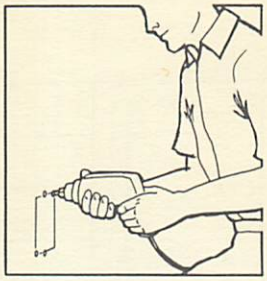
Fig. 89–Running Wires Beneath Walls or Under Floor.



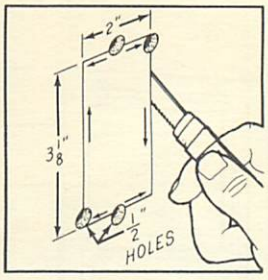
1. Locate studs in wall. Box should be mounted 4 to 5 inches from stud.



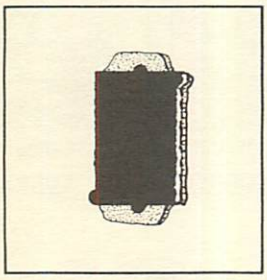
2. Outline the position for the box using template as a guide.



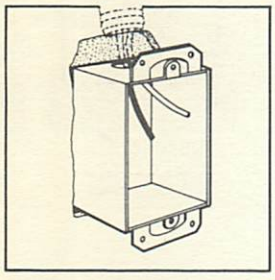
3. Drill four 1/2 inch holes in wall at positions indicated on template.



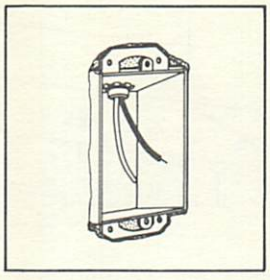
4. Use a hacksaw blade or keyhole saw to cut out hole for box. Use care to prevent loosening plaster.



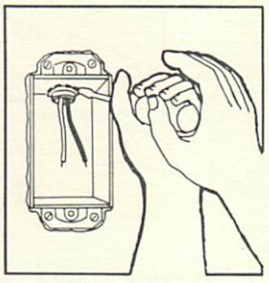
5. Trim away plaster to provide a solid and snug mount for the box. Remove appropriate knockout.



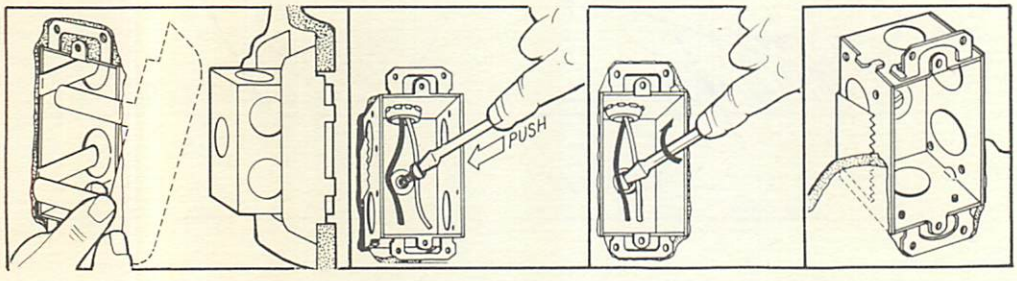
6. Pull wires into box. Locknut should not be on connector at this time. Slip box into hole.



7. Pull on lead wires to bring connector into knockout. Attach locknut.



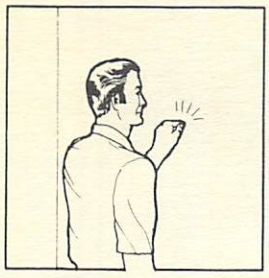
8. Tighten locknut and secure box.



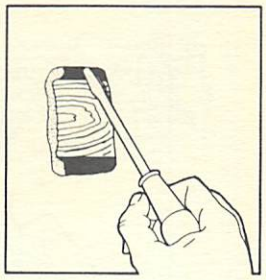
9. Secure box to wall in a manner best suited for the construction of the wall. Shown are two typical methods for securing a box in a wall. Additional boxes, with special mounting hardware attached, are available but are not shown here.

74-5611-c 1

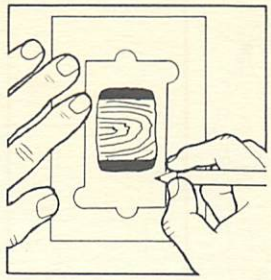
Fig. 90—Installing Box in Plaster Board Type Wall.



1. Locate studs in wall. Box should be mounted 4 to 5 inches from stud.

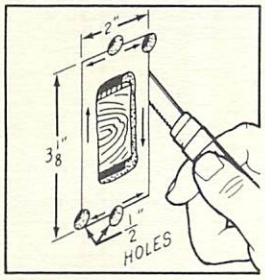


2. Remove plaster as shown. Expose one full lath.

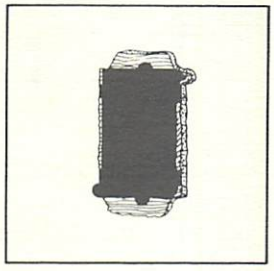


3. Center template for box over exposed lath. Outline the position for the box using template as a guide.

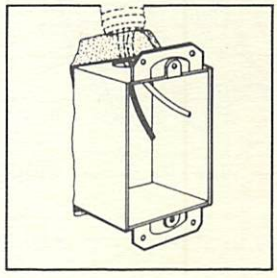
4. Drill four 1/2 inch holes in wall at positions indicated on template.



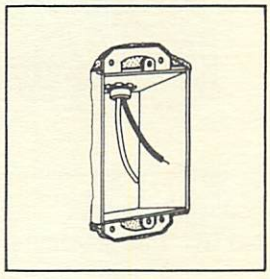
5. Use a hacksaw blade or keyhole saw to cut out hole for box. Use care to prevent loosening plaster.



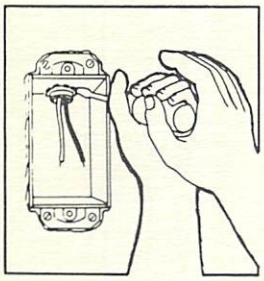
6. Cut away plaster and lath to provide a solid and snug mount for the box. Remove just enough plaster to allow box to fit hole.



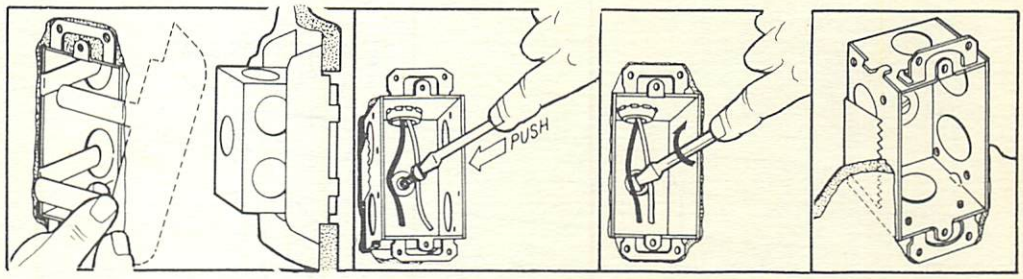
7. Remove knockout and pull wires into box. Locknut should not be on connector at this time. Slip box into hole.



8. Pull on lead wires to bring connector into knockout. Attach locknut.



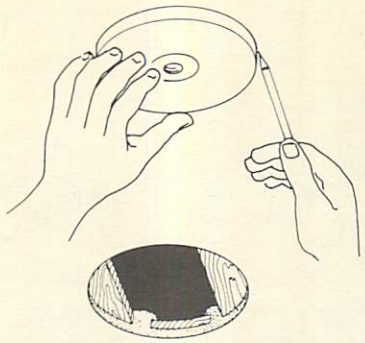
9. Tighten locknut and secure box to lath with No. 5 wood screws or proceed to step 10.



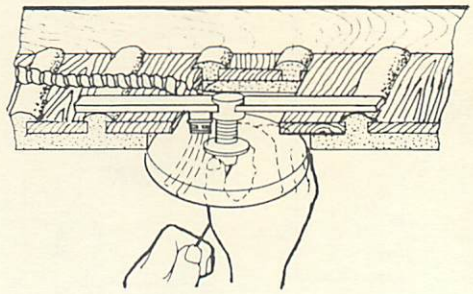
10. Secure box to wall in a manner best suited for the construction of the wall. Shown are two typical methods for securing a box in a wall. Additional boxes, with special mounting hardware attached, are available but are not shown here.

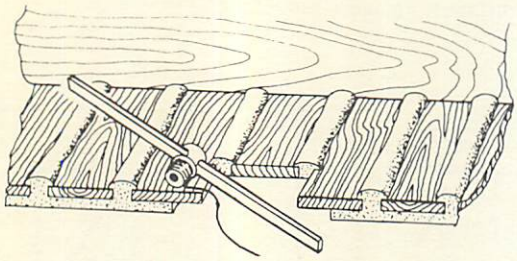
74-5611-cm

Fig. 91—Installing Box in Lath & Plaster Type Wall.



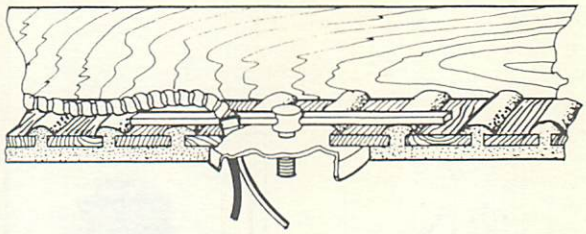
1. Mark location and then cut away plaster to size of a shallow box. Remove center lath.





2. Insert hanger (remove locknut and attach wire inside threaded stud).

NOTE: This procedure could be used to surface mount small boxes or other items.



3. Connect cable to shallow box. Slip wire (on hanger) through the center knockout of box and install locknut on threaded stud.

74-5611-cn

Fig. 92–Shallow Box and Hanger Installation.

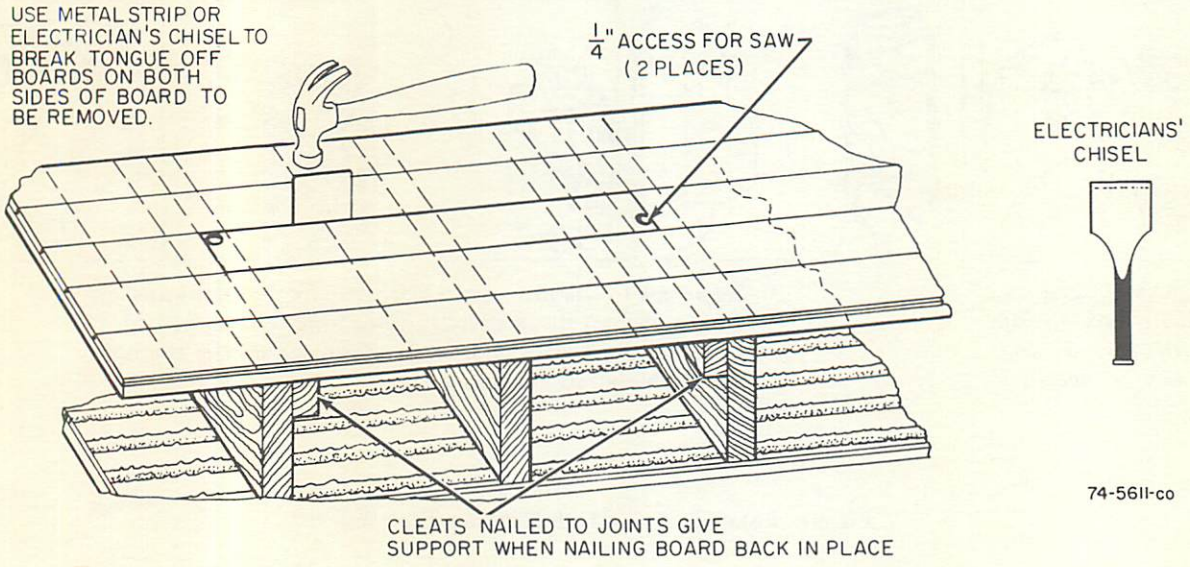


Fig. 93–Removing Floor Boards.

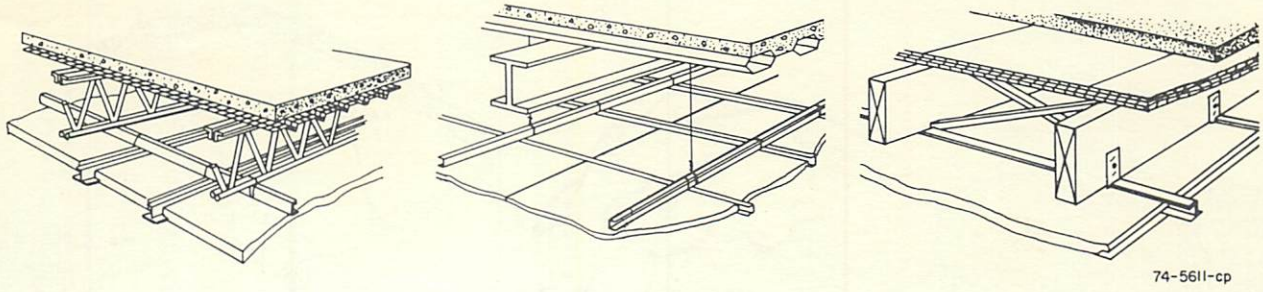


Fig. 94–Typical Suspended Ceilings.

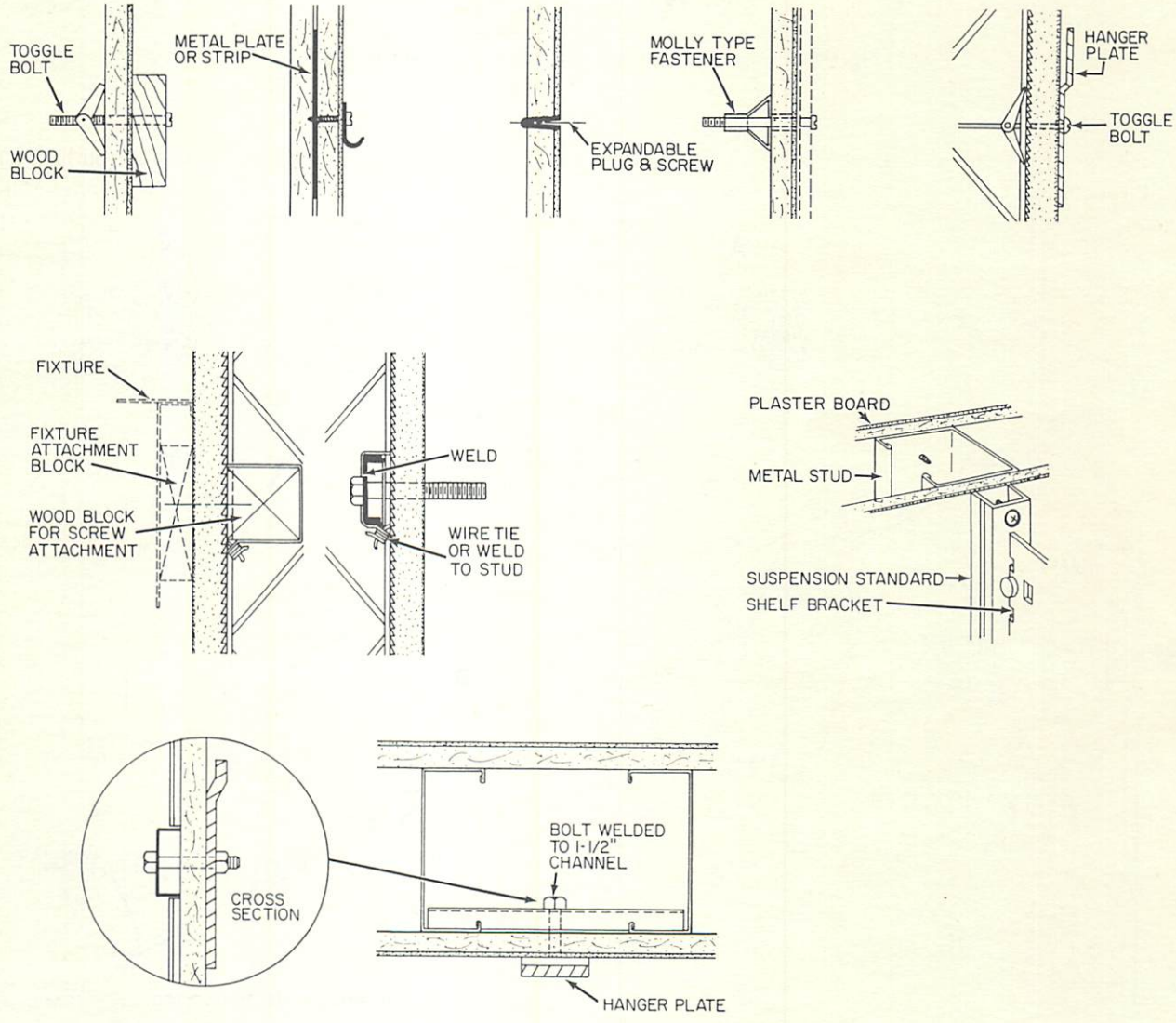


Fig. 95–Anchor and Hanger Installation – Commercial Construction

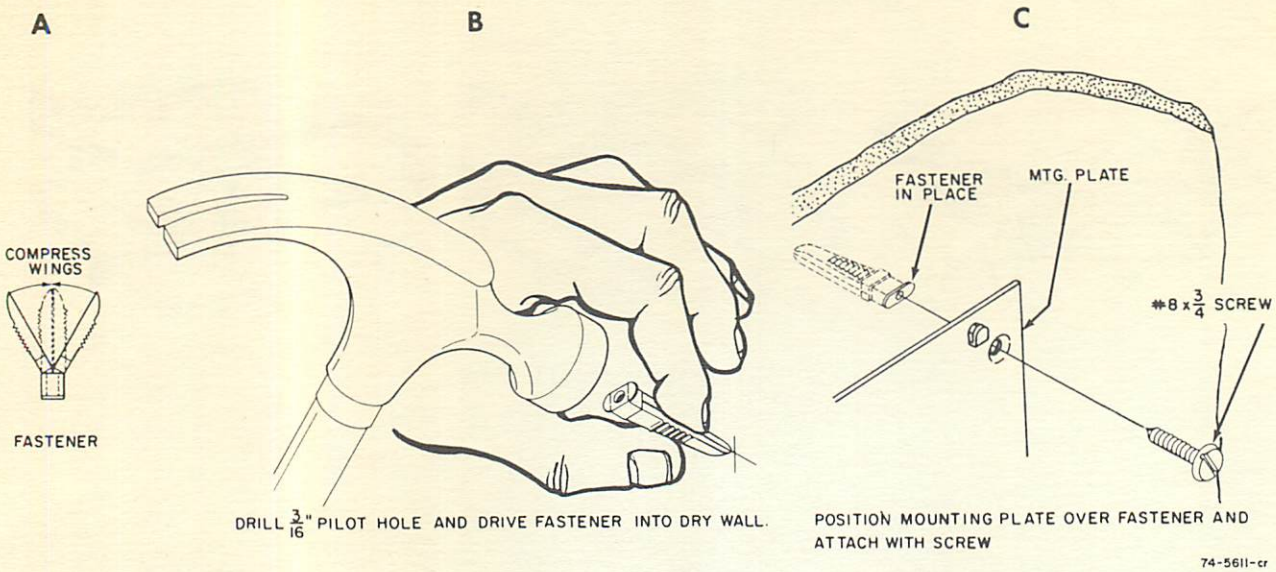


Fig. 96–Using Hilti Fastener and Screw to Mount Device.

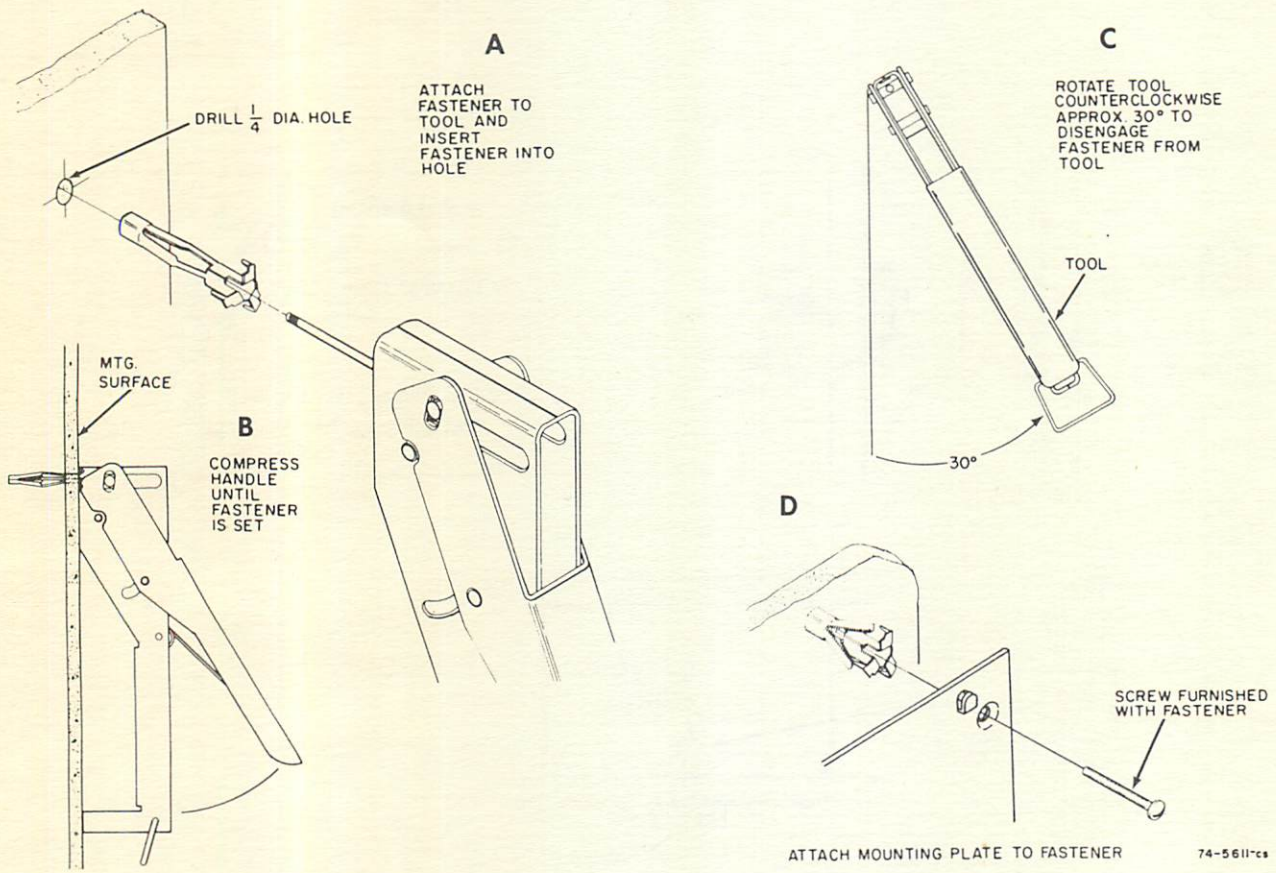
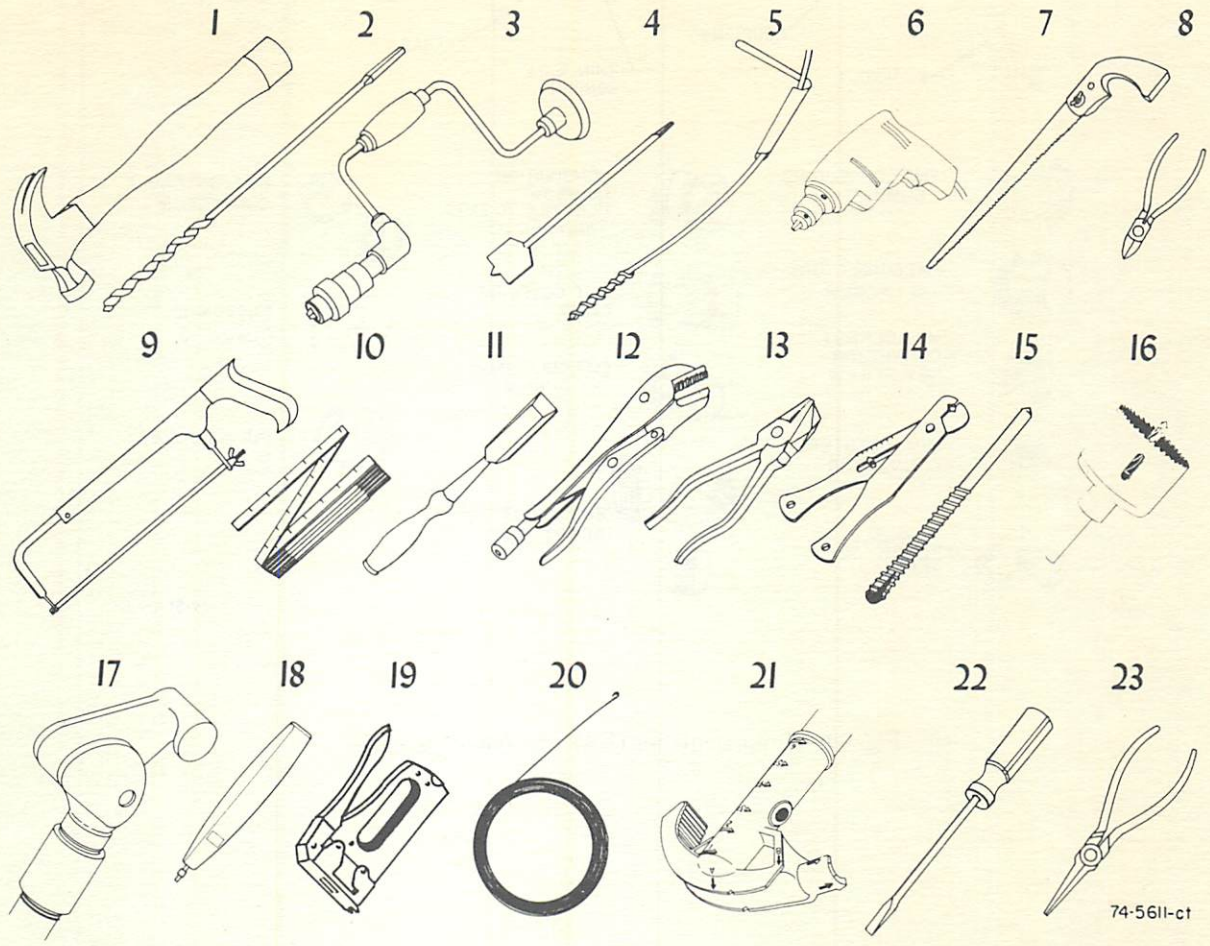


Fig. 97–Using a Wing-Ding Fastener and Tool to Mount Device.

HARDWARE ITEMS



No.	Item	Ademco Cat. No.	No.	Item	Ademco Cat. No.
1.	Claw Hammer		13.	Heavy Duty Wire Cutters	
2.	Wood "Feeler" Bit	7709, 7710	14.	Wire Stripper	241
3.	Brace		15.	Carboloy Drills	7700-7708
4.	High Speed Wood Bit		16.	Hole Saw & Arbor	7010-7015
5.	Flexible Bit & Guide Handle	7001-7005	17.	Hickey	
6.	Electric Drill		18.	Cordless Soldering Iron	7500
7.	Keyhole Saw		19.	Staple Gun	6006, 7006
8.	Diagonal Cutting Pliers	240-5, 240-6	20.	Snake	7711
9.	Hacksaw		21.	Conduit Bender	
10.	Folding Rule		22.	Screwdriver	
11.	Chisel		23.	Long Nose Pliers	
12.	Vise Grips				

Fig. 98–Typical Tools Used by Installer.

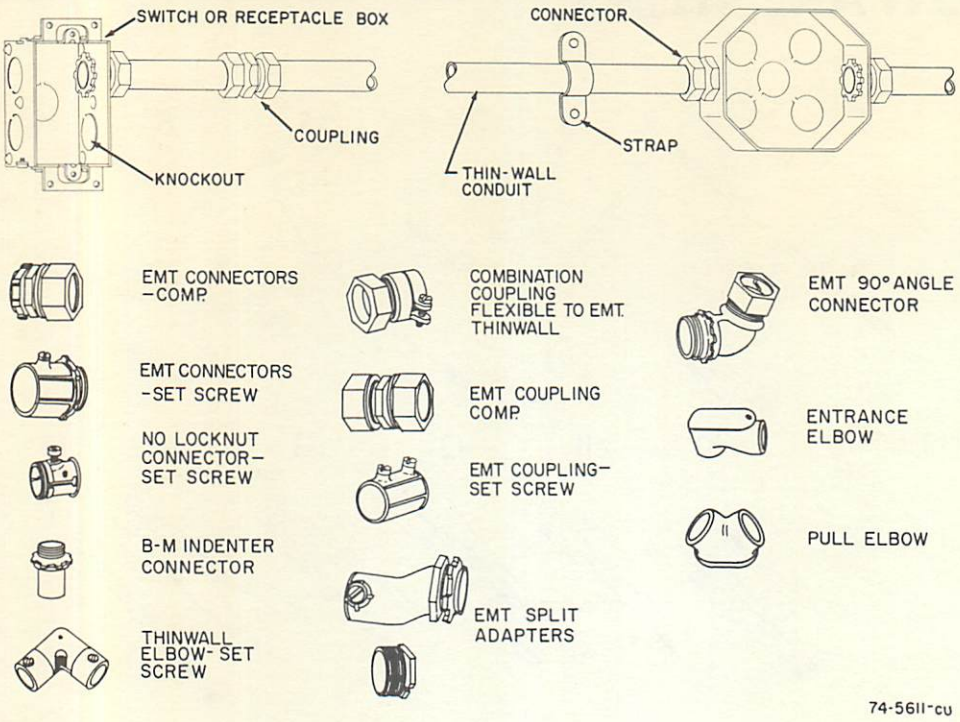


Fig. 99–Components for (E.M.T.) Conduit System.

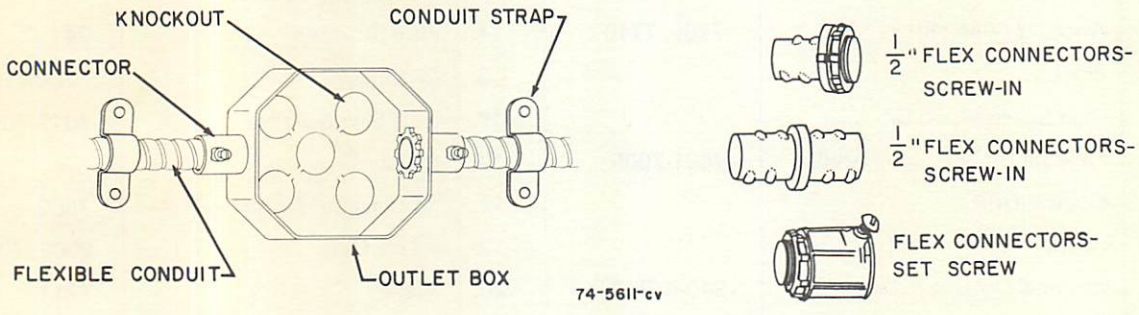


Fig. 100–Components for (Greenfield) Flexible Conduit System.

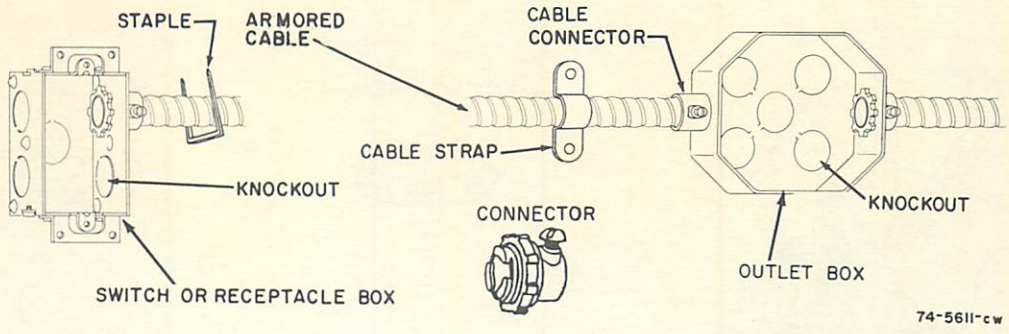


Fig. 101–Components for (BX) Armored Cable.

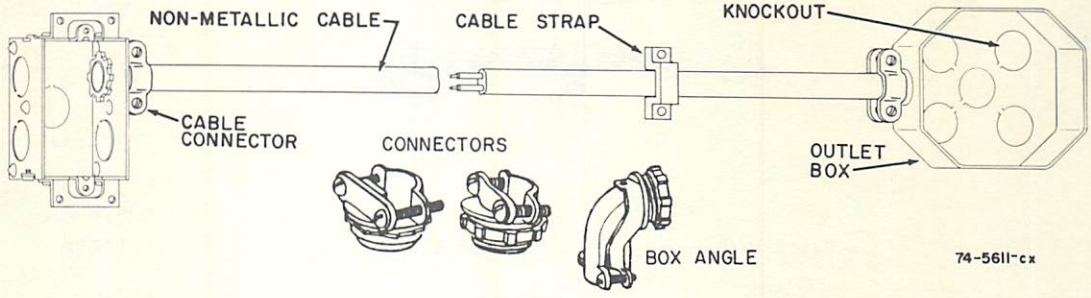


Fig. 102–Components for Non-Metallic Sheathed Cable.

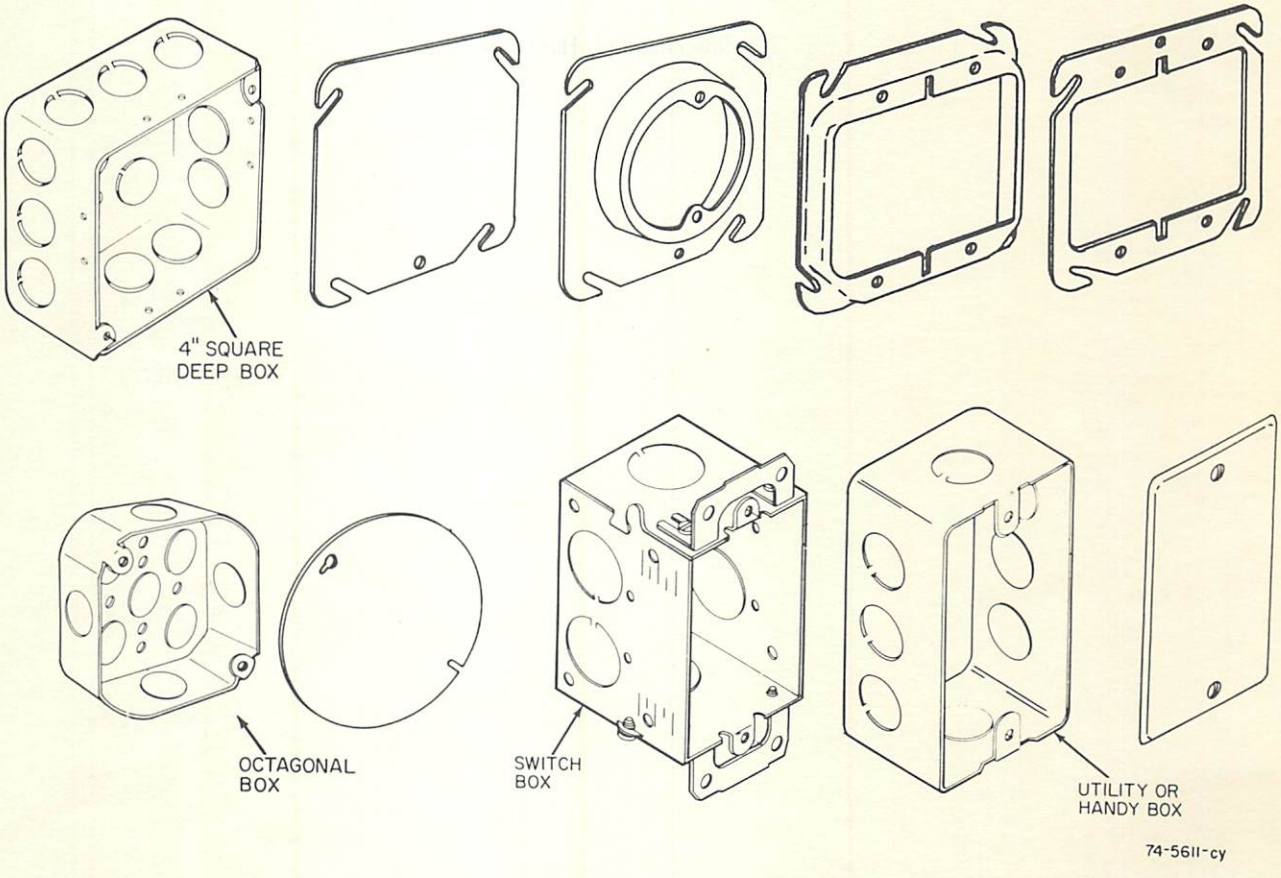


Fig. 103–Typical Boxes and Covers.

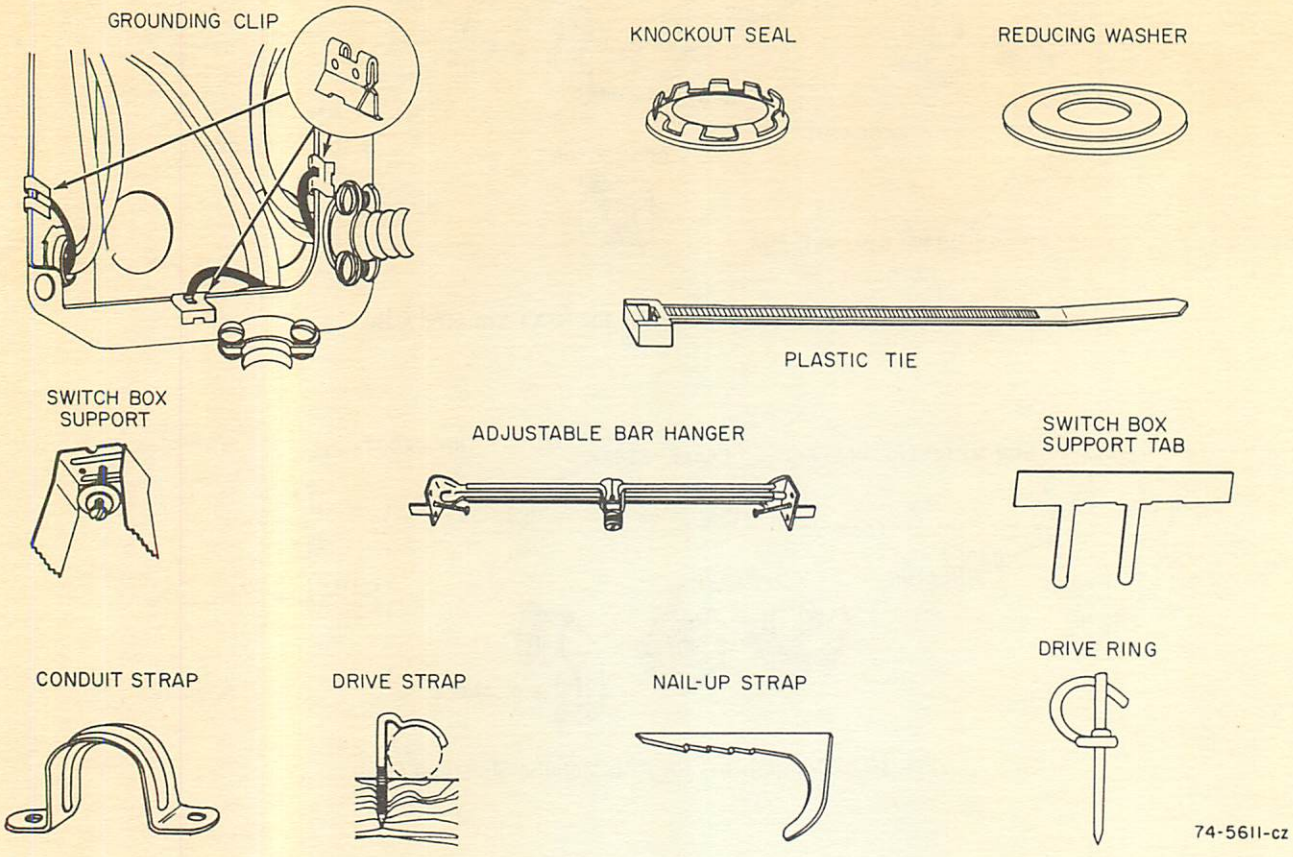


Fig. 104—Miscellaneous Hardware Items.

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